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Social antecedents and health consequences of productive activity

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SOCIAL ANTECEDENTS AND HEALTH CONSEQUENCES OF PRODUCTIVE ACTIVITY

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of

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To my beloved family and friends,

Without whom none of this would be possible.

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ABSTRACT

Kim, Seoyoun. Ph.D., Purdue University, May 2015. Social Antecedents and Health Consequences of Productive Activity. Major Professor: Kenneth F. Ferraro.

This dissertation consists of three empirical papers that investigate social antecedents and health consequences of productive activity. The ideas of productive activity and productive aging are the main concepts guiding the dissertation. The project is innovative by (a) testing how components of capital influence productive activities, (b) replicating analyses of productive activity and chronic inflammation in a Korean sample, and (c) examining sleep as a potential mediator and moderator of the relationship between productive activities and chronic inflammation. Chapter 2 attempted to contribute to the knowledge on productive aging by testing components of human, social, and cultural capital and older adults' participation in productive activities. In both cross-sectional and longitudinal analyses, education was related to all four types of productive activity (volunteering, meeting attendance, caregiving, and employment). Cultural capital was a consistent predictor of volunteering and meeting attendance. Chapter 3 then investigated whether multiple forms of productive activity affect health, focusing on chronic inflammation as a major physical health outcome in American and Korean older adults. The findings show gender-specific effects of employment and meeting attendance on inflammation in American older adults, but not in Korean older adults. Finally, Chapter 4 explicated the pathways linking productive activity and chronic inflammation in order to understand the underlying processes through which productive aging is beneficial to health. The results revealed that

insufficient sleep moderates the link between volunteering and inflammation. The project offers a fuller understanding of the factors that promote or hinder older adults' productive aging and how these activities influence chronic inflammation as a modifiable health outcome.

CHAPTER 1. INTRODUCTION

1.1 Objectives

The productive aging model is an emergent framework that emphasizes the continuity in older adults' participation in multiple productive roles (Morrow-Howell, Hinterlong, & Sherraden, 2001). This model was first developed in response to aging population in the world and to refute the negative stereotypes of older adults as being dependent on young adults' productivity. On one hand, a person retiring at the age of 65 in the United States still has the remaining third of his or her life in good health (Center for Disease Control and Prevention, 2014). On the other hand, there has been a general lack of structural or institutional support that creates more opportunities to meet these older adults' desire to stay active, a phenomenon termed as 'structural lag' (Riley & Riley, 1994). Therefore, productive aging, defined as any activity that produces goods and services, whether paid or not, that make a constructive contribution to community life (Bass & Caro, 2001, p.39), opens up new avenues for older adults to be as generative and healthy as they aspire. Much like the perspectives on 'emerging adulthood' (Arnett, 2000) or 'midcourse' (Moen, 2003), the productive aging model views later life as a significant life stage that provides new opportunities for older adults to engage in new roles, explore their lives proactively, and empower themselves.

At the heart of the productive aging model, older adults choose to partake in productive activity based on their evaluations of institutional and individual capabilities and options. It is important to recognize that the participation in productive activity is not entirely an individual decision. Rather, certain factors encourage or hinder older adults' decisions, whether they are

aware or not. Some studies have used the single predictor and single outcome approach, such as links between education and volunteering (Kim, Kang, Lee, & Lee, 2007) or health and caregiving (Bertrand et al., 2012). However, as the productive aging model posits, multiple resources influence productive aging and should be viewed as such. Thus, this project examines multiple resources and multiple forms of productive activity.

Another basic premise of the productive aging model is that assuming productive roles may lead to positive health outcomes. Regarding the health benefits of multiple role occupancy, two competing hypotheses have been proposed. The role strain hypothesis proposes that multiple roles may lead to ill health through either conflicts from incompatible demands between roles (role conflict) or overload caused by cumulative role obligations (role overload) (Coser, 1984; Goode 1960). Goode (1960) argued that the difficulty of assuming multiple roles becomes overly demanding as the actor feels difficulty in fulfilling role obligations. Empirical studies, however, failed to find extensive support for this hypothesis. It is noteworthy that studies that do find evidence for this hypothesis only counted obligatory roles in midlife (Reitzes & Mutran, 1994). Middle-aged adults assume multiple obligatory roles involving family or work relations that involve normative expectations and/or strong ties, making their exit difficult and often sanctioned.

Sieber (1974) expounded that role accumulation or multiple roles generally lead to rewards that outrun negative effects. Rejecting a simplistic notion that assuming multiple roles becomes incapacitating, Sieber argued that roles carry rewards, prestige, and satisfaction that outweigh the negative effects. Multiple roles offer a person four types of outcomes: "1) role privileges, 2) overall status security, 3) resources for status enhancement, and 4) enrichment of the personal and ego gratification" (p. 569). The identity accumulation hypothesis similarly states that "the more identities possessed by an actor, the less psychological distress he/she should exhibit… In other words, if one loses a valued identity,…not only may a profound sense of anxiety or depression be experienced, but severely disorganized behavior may result." (Thoits, 1983, p. 174-175).

Indeed, the role accumulation argument garnered substantial and consistent empirical support on a variety of health outcomes such as heightened sense of purpose in life, self-efficacy, greater positive affect, life satisfaction, and lower depressive symptoms (Adelmann, 1994; Ahrens & Ryff, 2006; Moen, Dempster-McClain, & Williams, 1992). What is more, any participation in the volunteer role was positively related to health regardless of when it occurred. The findings are consistent with unique benefits of voluntary roles, versus obligatory roles, as they are adopted by choice and can be exited fairly easily if the costs exceed the rewards (Thoits, 2012). Another study investigated the effects of multiple roles in the context of caregiving and found that older adults who take on roles in addition to caregiving, experienced positive and no negative effects on their self-rated health (Rozario, Morrow-howell, & Hinterlong, 2004).

More recent investigations turned their attention to how frequency of participation in a role may be consequential to the purported health benefits (Matz-Costa, Besen, James, & Pitt-Catsouphes, 2014). This line of inquiry calls attention to the subtle understanding of older adults partaking in multiple roles to varying degrees. Matz-Costa and colleagues (2014) found that psychological well-being is not predicted by simple role occupancy, but varies by individuals' level of participation. Investigations should aim to advance understanding of the health benefits of productive activity by taking into account the level of participation within roles. In this project, therefore, I examine the health consequence of frequency of activity within each role for volunteering, meeting attendance, caregiving, and employment.

Despite extensive scholarly interest on productive aging and how older adults are benefited by contributing to community life, there are at least three notable limitations in current knowledge. First, most studies rely heavily on self-reports of health or disease outcomes. If the benefits of productive activity extend to observable and objective health outcomes that are linked to major chronic diseases, productive activity may prevent morbidity and mortality in older persons before chronic diseases manifest. Thus, Chapter 3 attempts to extend our knowledge by

examining the health benefits of productive activity on a major physical health outcome: chronic inflammation.

Second, a major critique of the productive aging model is that the definitions and health benefits of productive activity, by extension, may vary in different cultural settings. Societies differ in their attitudes towards aging and what the aging experience entails. Further, 'productive' is a value-added concept and various cultures may prioritize different forms of productive activities over others in older adults. For example, volunteerism is a highly valued endeavor in the United States, but may not be so in other countries due to lack of opportunities or needs. Morrow-Howell & Wang (2013) recognized that culture operates as a critical backdrop of productive aging, and cross-cultural research is needed on differential health benefits of productive activity. Studying more than one population also offers practical implications because the global aging population is not homogeneous and will continue to grow not only in size but also in variability. The health implications or interventions of productive activity, thus, may not be identical in different population settings. I employ two datasets from the United States and South Korea to test if the health benefits are comparable between the two countries.

Finally, the literature on productive aging links various forms of activity to health outcomes, but few studies examine potential pathways to explain why there are such benefits. On the link between social environment and chronic inflammation, sleep quality is shown to function as a potential moderator or a mediator (Cho, Seeman, Kiefe, Lauderdale, & Irwin, 2015; Friedman et al., 2005). Thus, the final empirical chapter examines moderating and mediating pathways through which multiple forms of productive activity potentially reduce inflammation.

In sum, the current dissertation probes the following three research questions.

1. *Do human, social, and cultural forms of capital predict individuals' participation in productive activities?*

2. *Does participation in various productive activities reduce inflammation in American and Korean older adults?*
3. *Is sleep quality implicated in the relationship between productive activities and inflammation?*

CHAPTER 2. SOCIAL ANTECEDENTS OF PRODUCTIVE ACTIVITY: THE ROLE OF HUMAN, SOCIAL, AND CULTURAL CAPITAL?

2.1 Abstract

Objectives. Using the productive aging model, the study investigates the relationship between human, social, and cultural capital and multiple types of productive activity.

Method. Analyzing data from two waves (W1 in 2005, W2 in 2010) of the National Social Life, Health, and Aging Project (NSHAP), I tested whether human capital (education, functional limitations), social capital (marital status, network size, social support), and cultural capital (religious service attendance) predict participation in productive activities. Four activities were assessed, including volunteering, meeting attendance, employment, and caregiving.

Results. Human capital was related with all four types of productive activity in both cross-sectional and longitudinal analyses. Social capital was associated with volunteering and meeting attendance, but this link was attenuated in the longitudinal analyses adjusting for the baseline level participation. Cultural capital was a consistent predictor of volunteering and meeting attendance in both cross-sectional and longitudinal analyses.

Discussion. Two important implications of these findings are that productive activities occur in the context of available human, social, and cultural capital, and that social factors influence productive activities differently, warranting more investigations of multiple productive activities or 'activity profile' over the life course.

Key words. Productive activity, Productive aging model, Capital, Older adults

2.2 Introduction

The older adult population in America is growing faster than ever, with roughly 10,000 baby boomers turning 65 every day since 2011 (Pew Research Center, 2010). They are also living longer with better health than their preceding cohorts, which results in a greater reservoir of older adults with talents, experiences, and abilities. In the face of this aging trend (also dubbed as 'The Silver Tsunami') and related social issues such as long-term care, pension, and social security, policy makers and scholars have been concerned with ways to promote health and well-being in those extended years. The productive aging model was first developed as part of this collaborative effort to extend productive life for older adults and to counter stereotypes of older adults for being dependent on the productivity of younger generations (Bass & Caro, 1995; Butler, 1989). Robert Butler (1989), who first coined the term 'productive aging', contended that society should transform the current social structure to create opportunities for older adults to stay active and healthy beyond mere survival.

At the heart of the productive aging model is the notion that all aging experiences are embedded within the society and shaped by various social contexts. Indeed, research focuses on factors that encourage later life productive activities, showing that certain types of social resources (i.e., capital) are more likely to influence productive activities than others (McNamara & Gonzales, 2011; Musick & Wilson, 2007). However, very little attention has been given to predictors of *multiple productive activities over time*. Cross-sectional data lose information on whether resources promote long-term participation in productive activities. Studying the maintenance of activities may have implications for interventions regarding the recruitment and retention of older adults in various organizations. Since older adults participate in various activities to varying degrees over time, the question remains whether the resources that affect baseline participation level also influence the changes in productive activities.

Employing the productive aging model and the concept of capital as the main conceptual underpinnings, the current study investigates the effects of human, social, and cultural capital on productive activities. Using longitudinal data from a nationally representative sample of the U.S. population, I consider multiple forms of productive activity that are prevalent among older adults; namely volunteering, meeting attendance, employment and caregiving. The main research questions are twofold: a) are human, social, and cultural capital associated with the baseline level participation in productive activities and b) do these capitals predict the maintenance or initiation into these activities?

2.2.1 Defining Productive Activity

Since the initial use of the term productive activity, multiple scholars have offered conceptual and operational definitions but there appears to be lack of agreement among the disciplines regarding what constitutes 'productive aging.'[1] Sociologists advocate productive aging as a positive perspective of aging that counters the stereotypical depictions of older adults as passive consumers of gross domestic product (Bass, Caro, & Chen, 1993). As such, productive activity is defined as any activity that contributes to the larger community regardless of wage acquisition. Economists tend to consider productivity somewhat more narrowly than sociologists, only including activities that generate monetary returns or can easily be monetized. As economist James Morgan (1986) suggested, productive older adults reduce the demands of goods and services produced by others and create a higher quality of living for the community. Defying the view of productive aging from solely a monetary standpoint, however, some scholars in the field of social work, nursing, and psychology include leisure, do-it-yourself activities, and social activities because they promote older adults' physical and mental well-being (Register & Herman, 2010). Commonalities among all major disciplines are that older adults are making an

[1] See Appendix A.

active contribution to the community, but there is no unifying definition of productive activity among older adults.

A very narrow or a very broad definition of productive activity can be equally problematic. On the one hand, limiting productive activity to strictly monetary criterion may lead to definitions that are not relevant in the current aging society. On the other hand, an extremely broad definition of productive activity includes all activities loses some of its utility as a concept for empirical research. Thus, adopting a widely-used definition by Bass and colleagues (1993), I take the position that productive activities should *not solely benefit the actor* (either paid or unpaid); productive activity should make a constructive contribution to community life.

The components considered germane include market-based economic activities (paid work), non-market activities with economic value (volunteering or caregiving), self-improvement (education, training), and self-care (Bass & Caro, 1995; Sherraden, Morrow-Howell, Hinterlong, & Rozario, 2001). Based on these criteria, previous research has used somewhat distinct operational definitions of productive activities. In this project, I focus on four specific activities: (1) volunteering, (2) meeting attendance, (3) caregiving, and (4) paid work. Volunteering and paid work are most commonly recognized as productive activities by multiple studies (Hinterlong, 2008; Morrow-Howell, Hinterlong, & Sherraden, 2001; Musick & Wilson, 2003). Caregiving is also widely considered as a significant form of productive activity; the age of caregivers is rising, and the contribution of older caregivers generates benefits for the nation and those served (AARP, 2012). Though studied less frequently, community engagement is a type of productive activity (Burr, Caro, & Moorhead, 2002). Community engagement encompasses various activities such as voting, attending community meetings, and making financial contributions to community organizations. Using the data from the Boston Area Study, Burr et al. (2002) demonstrates that meeting attendance is a prevalent type of community engagement for older adults since it requires a modest commitment of time and skills. In the current project,

housework and do-it-yourself activities are excluded because, contrary to the conceptual definition, these activities are typically accomplished in isolation and often benefit solely the actor.

2.2.2 Prevalence of Productive Activity

The extent to which older adults are active in their communities has been of interest in societies with a growing number of older adults, but how prevalent are productive activities among older adults? Despite a description of older age as notably 'roleless' (Burgess, 1960), research shows that the majority of older adults make both market and non-market contribution that generate substantial benefits for the nation and community. When each activity is examined separately, current national statistics show that volunteering and meeting attendance are more prevalent while caregiving and employment are less common types of activities in later life.

Volunteering. Older adults are fairly active in their voluntary work. The U.S Bureau of Labor Statistics (2013) estimates that about one in four Americans 65 years and older is engaged in volunteer work, comparable to adults ages 16 to 64, and the number has been stable for the past 5 years. Though volunteers at any age spent a median of 50 hours a year on volunteer activities, older volunteers devoted more time (86 hours) than did their younger counterparts (Herzog, Kahn, Morgan, Jackson, & Antonucci, 1989). Among institutions, religious organizations play a significant role in providing older adults with opportunities for volunteer activities (Musick & Wilson, 2007). Among volunteers age 65 and over, 43% did their service mainly through or for a religious organization, compared with 27% of volunteers age 16 to 24.

Organized Meeting Attendance. Political and civic participation declines slightly with age yet still remains relatively high over the life course. In fact, the level of civic participation activities (e.g., voting, making contributions to community, attending meetings) in the 65 and older age group appears not very different from that of the 55-64 age group. Burr and colleagues

(2002) used a sample from middle-aged and older adults residing in the Boston area and reported that 22.3% of adults 60 and older attended neighborhood meeting regularly in the past year, compared to 26.6% for 40-59 age group and 14.7% for 18-39 age group.

Employment. The age-specific employment rate after 65 is relatively higher in the U.S. compared to other developed countries. For the 65 and older age group, around 17% were employed in 2013, much higher than 5% in the EU nations (U.S. Bureau of Labor Statistics, 2013). Between 1990 and 2010, employment rate for workers 65 and older increased by 33%, from 12% to 16% (U.S. Bureau of Labor Statistics, 2013). Broken down by gender, the employment rate rose from 18% to 21% for older men and from 8% to 13% for older women in the last two decades, showing a more drastic gain among older female employees. By 2016, older workers are expected to make up about 6% of the total labor force compared to 3.6% in 2006, and this will have implications for pension, retirement benefits, and healthcare policies.

Caregiving. The average age of caregivers has risen over the past decade, from 46.4 in 2004 to 49.2 in 2012 according to the National Association of Caregivers and AARP (2012). AARP (2012) also estimates that about 9% of all caregivers are 65-74 years old, and 4% are over the age of 75 with about one third of these older care providers in fair or poor health themselves. The number of hours dedicated per week increases with the age of caregivers; caregivers over 65 years of age spend 32 hours per week caregiving on average compared to 25 hours for 55-64 age group. Contrary to popular depiction of older adults as mostly care recipients, the national trend indicates that they also provide care to their parents, friends, and relatives with spousal caregiving being the most prevalent type of caregiving (Bass & Caro, 2001).

2.2.3 Antecedents of Productive Activity: The Productive Aging Model

Why do some people engage in productive activities while others do not? Though Robert Butler (1989) initially emphasized the role of social environments on productive aging, Bass and

Caro (1995) were the first scholars to provide the conceptual model, focusing on how environmental, situational, individual, and social policy factors are intricately related with productivity in later life. Graphically depicted in Figure 2-1, Sherraden and colleagues (2001) extended this model to explicate that demographic factors (e.g., gender, race) influence individual capacity while public policies (e.g., programs, regulations, taxation) influence institutional capacity for productive activity. Productive activity is considered as intermediate outcomes, affected by social antecedents, and subsequently influence various individual and community outcomes.

<Figure 2-1 about here>

The social antecedents of productive activity include both micro- and macro-level variables. At the core of this model, it notes that individuals choose to participate in productive activity based on an evaluation of his or her individual and environmental capabilities and options. In turn, later life productivity results in positive outcomes relevant to individuals, families, and societies. Expanding further on Sherraden and colleague's research, Morrow-Howell and Wang (2013) recognized culture as an important and understudied milieu in understanding productive activities in various societies.

As per the Sherraden et al. (2001) model (adopted from p.275):

- *Demographic* variables include any individual characteristics that could be related to individual capacity (e.g., age, gender, race/ethnicity, education, and urban-rural location);
- *Individual capacity* includes individual traits that affect individual decisions to engage in productive activities (e.g., health, cognitive functioning, time available, social support);
- *Public policy* is any institutional or community characteristics that facilitate later life productivity (e.g., programs, regulations, and taxation);

- *Institutional capacity* is institutional factors related to productivity in older adults (e.g., the extent to which institutions make opportunities available to older adults, the number and quality of these roles);
- *Productive activity* refers to both "market and non-market activities with economic value, formal social and civic activities, and informal social assistance" (p. 275); and
- *Outcomes* refer to the effects on the well-being of individuals, families, and societies.

One should note that productive aging is distinctive from three alternative concepts that are sometimes used interchangeably: active aging, healthy aging, and successful aging. Active aging refers to the continued involvement in social, economic, spiritual, cultural, and civic activities, through which individuals or population groups enhance their well-being (World Health Organization, 2001). Healthy aging entails a process during which older adults "resiliently adapt and compensate in order to optimally function in all areas of life" (Hansen-Kyle, 2005, p.52). Successful aging recognizes three aspects, including freedom from major diseases/disability, good physical and cognitive health, and ongoing participation in various types of activities (Rowe & Kahn, 1997). Similar yet distinct from these three concepts, productive aging focuses on active contributions that older adults make, and points to both the causes and consequences of productive activity in later life (Morrow-Howell et al., 2001). Each concept, however, broadens the possibilities for older adults.

Though the underlying assumptions of the productive aging model are widely accepted as a positive way of aging, some scholars are concerned about its negative implications on government programs that support older adults. Critical gerontologists such as Harry Moody (1993) and Carol Estes & Jane Mahakian (2001), while recognizing positive aspects of productive aging, argue that this trend may dichotomize aging as productive or unproductive (i.e. dependent) processes and create yet another competitive system in later life. If activity patterns among older adults are mainly contingent upon their socioeconomic status, the productive aging model may

become an extension of market logic in later life, further marginalizing disadvantaged groups. At the core of this debate is the tension between opportunity and coercion. Many older adults have talents and capabilities to stay active, but one should acknowledge that a segment of population has limited resources to participate in productive activity. Thus, the ultimate goal of productive aging should be to broaden the opportunities and eliminate barriers to activities so that healthy and highly functioning older individuals are not constrained to leisure roles.

While the productive aging model provides the conceptual background on how older adults' capacity leads to productive activity, the current project situates activities within the concept of capital, demonstrating the role of human, social, and cultural capital on a behavioral outcome that is productive activity. The concept of capital sheds light on several critical questions regarding the productive aging model, such as: Which form(s) of capital exerts the greatest effect on participation and frequency of productive activity? Do different forms of capital cancel out or work together to promote productive activity? For example, according to the productive aging model, health and social support are both considered components of individual capacity, but health is a resource largely embedded within an individual while social support emanates from one's relationships and networks. Studying capital elucidates whether individuals choose to participate in productive activity mainly because of their attained status, social relationships, their values in helping others, or a combination of all of these factors. Policy makers and planners can also consider ways in which intervention programs can enhance different forms of capital to encourage older adults who desire to stay productive in later life.

The concept of capital has been initially developed in economics literature but extended to include not only human capital but also social and cultural capital. In general, capital refers to resources that have potentially tangible values and can be used to produce other forms of returns (Bourdieu, 1986). Human capital can be broadly defined as resources embedded within the individuals, such as knowledge, education, and functional ability which are valued in paid and

unpaid labor market (Becker, Murphy, & Tamura, 1990). Distinct from human capital, social capital exists when social relationships among individuals or organizations have a potential for benefiting the members (Coleman, 1988). Social networks operate through facilitating information among the members, influencing individual decisions, providing resources beyond a person's human capital, and reinforcing identity (Lin, 2001). As such, social capital promotes individual's decision to participate and maintain multiple types of productive activities (Musick & Wilson, 2007). Finally, cultural capital indicates shared symbolic meanings, values, and ways of relating to others that have economic or social 'profits' (Lamont & Lareau, 1988; Portes, 2000). In the U.S. society, cultural values and behavioral expectations are exemplified by the role of religion in person's lives. Religious organizations often make conscious efforts to emphasize the connection between faith and one's active role in the society, and this may profoundly influence parishioners' orientation towards work (Davidson & Cadell, 1994), caregiving (Stuckey, 2001), and civic engagement (Musick & Wilson, 2007).

Empirical studies indicate that individuals equipped with human, social, and cultural capital are more likely to engage in productive activity across different cultures (Kim et al., 2007; McNamara & Gonzales, 2011; Musick & Wilson, 2007). Volunteers are relatively healthy, well-educated, married, and more religious than non-volunteers (Bass & Caro, 1995; Choi, 2003). For meeting attendance, a small yet growing body of research indicates that similar social antecedents apply to both volunteering and meeting attendance (Burr et al., 2002). Frequent religious participation, education, marital status, and health are all correlated with civic participation, including meeting attendance. Employment is highly correlated with human and social capital such as education, health, network size, and marital status, which may be indicative that there are more barriers to entry into the labor market for older adults, particularly when they experience a decline in health (Schmitz, 2011). Though less attention has been paid to the role of cultural capital on employment, Weber's thesis that considers work as a 'calling' has been investigated in

the literature (Davidson & Cadell, 1994), showing that frequent religious service attenders were more inclined to view their work as a calling or career rather than a simple job to make ends meet. Finally, older caregivers are more likely to be female, non-White, healthy, unemployed, and have a larger social network compared to non-caregivers (Boerner & Reinhardt, 2003). Recognizing the significance of health and physical functioning in the caregiving activity, the healthy caregiver hypothesis has been proposed, suggesting that healthier people are selected into caregiving and derive further health benefits from the activity (Bertrand et al., 2012). Religious beliefs are also found to directly affect the motivation to care for frail family members or relatives (Stuckey, 2001), a finding that signifies the role of cultural capital on the norms and ideas to appropriately provide help for those in need.

Drawing on conceptual and empirical research on productive activity discussed so far, I hypothesize that human, social, and cultural capital predict multiple types of productive activity, namely volunteering, meeting attendance, employment, and caregiving. I use both cross-sectional and longitudinal data in order to examine not only the baseline levels of participation but also the changes in these activities.

The study seeks to contribute to the literature in several important ways. First, the current study adds to the life course perspective on productive activity by examining the role of capital on long-term participation in productive activity, taking into account non-random attrition effects. Second, while most studies focus on one specific activity, activities do not occur alone but in patterned ways. I am unaware of any study that systematically examines multiple productive activities using longitudinal data. This study elucidates how productive activity is a confluence of capital and other activities over time.

2.3 Methods

The study uses two waves of data, hereafter W1 and W2, from the National Social Life, Health, and Aging Project (NSHAP), a representative, population-based sampling of older adults in the United States. NSHAP W1 was collected in 2005-2006 and comprised of 3,005 respondents with a response rate of 75.5%. The productive activity items (except for employment) were included in the leave-behind questionnaire (LBQ). The response rate for the LBQ was 84% (n=2,524) at Wave 1. At Wave 2, collected in 2010-2011, 89.4% of the W1 respondents were reinterviewed and among those who completed in-person interview, 89% returned the LBQ. This results in the final analytic sample size of 2,008 at the second wave. Due to missing data in independent and dependent variables, the statistical analyses for each productive activity has a slightly different sample size. Detailed sample flow charts are presented in Appendix C.

2.3.1 Measures

Dependent Variables: Productive Activity. Four productive activities were examined: volunteering, meeting attendance, employment, and caregiving. I created a binary variable of each productive role to examine whether respondents participated or not at each wave. For *volunteering*, respondents were probed how often they volunteered for religious, political, charitable, health-related, or other organizations in the past 12 months. Responses ranged from never (0) to several times a week (6). Using the same response categories as for volunteering, respondents were also asked about their frequency of *meeting attendance* of any organized group(s). For *employment*, respondents reported the number of hours they typically work during a week. I defined those who work 40 hours or more a week as full-time workers, resulting in three categories; non-workers (0), part time workers (1), and full-time workers (2). An alternative threshold for full time employment (i.e., 35 hours a week) was tested and there were 69 individuals at W1 who worked between 35 to 39 hours. Since additional analyses show no

differences between the two full-time employment groups in terms of age, education, health, life style factors, and productive activities, the 40-hour threshold was used, consistent with the literature (Burr, Mutchler, & Caro, 2007). For *caregiving*, respondents were asked whether they are currently assisting an adult who needs help with day-to-day activities because of disability. If answered yes, they were then queried how many days per week they typically spend caring for this person. Original responses ranged from 0 to 7 days. However, because the majority of respondents reported either providing no care or full-time care, I created three ordinal categories for non-caregiver (0), part-time (1), and full-time (2).

Independent Variables.

Human Capital. Education and functional limitations were measured for human capital. For *education*, four categories of educational attainment (less than high school (0), high school, some college, and college or more (3)) were included. *Functional limitations* were indicated by reported difficulty with six items for Activities of Daily Living (ADL). The ADL items included difficulty walking across a room, dressing, eating, bathing or showering, getting in and out of bed, and using the toilet. For each task, respondents were asked to indicate whether they had no difficulty (0), some difficulty (1), much difficulty (2), or were unable to do (3). The items were then summed for a range of zero to eighteen, where higher scores indicate greater functional limitations. The supplementary analyses did not indicate a substantial difference between the original coding and alternate coding schemes (e.g., sum of dichotomous indicators).

Social Capital. For social capital, marital status, network size, and support were measured. *Marital status* was dichotomized with 1 indicating married or cohabiting with a partner. To tap close *network size*, respondents were asked to report the number of individuals with whom they can discuss matters that are important to them (the core discussion network). The answers ranged from none (0) to six or more (6). For perceived *social support* from family,

respondents were asked “how often can you open up to members of your family if you need to talk about your worries?” and “how often can you rely on them for help if you have a problem?” The answer ranged from hardly ever or never (0) to often (2). The same two items were repeated for spouse and friends. This results in total of six possible items on social support. Since some respondents were not asked the entire set of six questions based on their reports on number of friends (if reported having no friend) or marital status (if not married), the items were averaged by the number of valid answers to create an overall social support index ranges from 0 to 2, where higher numbers indicate greater social support.

Cultural Capital. *Religious service attendance* was measured for cultural capital that is conducive to productive activities. A measure for religious service attendance comes from an item that asked how often respondents attended religious services within the last 12 months. Reponses were rated on an ordinal-level scale ranging from never (0) to several times a week (6).

Additional Covariates. In addition to central variables of interest, several covariates were included because of their association with productive activity. *Age* is coded in years, and sex is dichotomized with 1 indicating *female*. Race was divided into a series of binary variables (*White*, *Black*, and *other race*) with non-Hispanic White serving as the reference group. Due to small sample sizes (6.42% of all analytic sample), other race groups were combined, consisting of Hispanic Americans, Native Americans, Asian or Pacific Islander, as well as those identifying themselves as ‘other race’. *Depressive symptoms* were included in the analyses based on the 11-item Center for Epidemiologic Studies Depression Scale (CES-D) (Chronbach’s $\alpha = .80$). For health lifestyle variables, I included W1 *tobacco use*, *physical activity*, and *obesity*. Participants who reported as currently smoking cigarettes, pipes, cigars, or chewing tobacco, were classified as current tobacco users. *Physical activity* was measured with an item probing respondents’ engagement in physical activities such as walking, dancing, or exercise (0=never, 1=once a month, 2=one to three times a month, 3=one or two times a week, 4=three or more times per

week). *Obesity* is defined by body mass index values equal to or higher than 30 kg/m^2. Respondents' weight and height were measured by the interviewer with a scale and measuring tape, not provided by the respondents. Supplementary analyses considered additional variables including respondents' income, wealth, self-rated mental and physical health, total volume of contact with core network members, living arrangements (i.e., number of people living in the same household), stroke, hypertension, and cancer. These variables were omitted from the final analyses for more parsimonious models because they were not significant in any of the multivariate specifications.

2.3.2 Analyses

The statistical analyses were conducted under the assumption that certain types of productive activities are maintained while others are not. Logistic regression models were used to predict the participation in each activity role at Wave 1 (W1) and Wave 2 (W2). For volunteering, meeting attendance, and employment, a subsample of respondents who were undertaking a role at W1 was examined to predict the maintenance of activity during the 5-year period. For caregiving, respondents who were *not* providing care at W1 were included in the logistic regression model to examine what factors influence the initiation of these activities across waves.

Separate models were estimated for the frequency of activity within each role. Frequency for volunteering and attending meetings ranges from 0 to 6 and is normally distributed, and the analyses used ordinary least squares (OLS) regression to model the W1 frequency of activity and change in activity (by regressing W2 frequency of activity on W1 level). Frequency for employment and caregiving ranges from 0 to 2 and the ordinal logistic regression models were used to predict the W1 and W2 frequency of activities. For employment, analyses for W2

participation frequency included respondents who worked at W1. For caregiving frequency at W2, respondents who were not providing care at W1 were included in longitudinal analyses.

A series of supplementary analyses were conducted to test the robustness of the results. I first estimated the changes in frequency of activity across waves using multinomial logistic regression with -1 indicating a decrease, 1 indicating an increase, and 0 reflecting no change in the given activity between waves. The results from multinomial logistic regression are shown in Appendix D. Further, I conducted ordinal logistic regression to predict the frequency of volunteering and meeting attendance using both cross-sectional and longitudinal data, since categories of these activities were originally measured at ordinal level. The substantive conclusions were unchanged, and I focused on OLS regression because of its greater ease in interpreting coefficients. The results from ordinal logistic regression analyses are presented in Appendix E.

Finally, though re-interview rates were relatively high in the follow-up study, sample attrition primarily due to death may produce biased parameter estimates in longitudinal analyses. In order to adjust for differential selectivity due to death, Heckman's (1979) selection bias models were employed. I first estimated a probit model to distinguish respondents who participated at the follow-up interview from those who died. Predictors of mortality in the probit model included age, female, and tobacco use along with variables that were not included in the substantive equation predicting productive activity (i.e., walking a block, underweight [BMI < 18.5], self-rated mental and physical health). The selection lambda (λ) based on the inverse Mills ratio was subsequently included in the models.

2.4 Results

Table 2-1 summarizes the descriptive statistics for study variables. At baseline, a majority of respondents either volunteered (63%) or attended meetings (69%) in the past year,

with 56% participating in both activities. In terms of the frequency of each activity, almost one third of the sample volunteered and half attended meetings at least once a month. Employment and caregiving were less prevalent, with 30% workers and 17% caregivers in the sample. Though the vast majority of respondents did not provide care, among 327 who did, 52% were part-time and 48% were full-time caregivers, meaning that they were assisting care recipients 7 days a week. Among older employees, 48% were part-time and 52% were full-time workers.

<Table 2-1 about here>

At W2, the prevalence of volunteering and meeting attendance remained at 62% and 70%, respectively, indicating considerable stability in these activities over time. In addition, the frequency of volunteer activity did not necessarily decrease over time; among W1 volunteers, 42% showed a decrease, 24% experienced no change, and 34% showed an increase in the frequency of activity. Similarly, more than half of those who attended meetings at W1 maintained or even increased their frequency of activity at W2. However, employment declined from 30% to 10% in the entire analytic sample with 44% of the workers being employed full-time. Finally, though the proportion of caregiver remained stable (17% at W1, 16% at W2), many respondents moved in and out of the caregiving category. Among W1 caregivers, 71.9% stopped providing care while 6.9% of W1 non-caregivers started caregiving activity by W2. All in all, descriptive analyses revealed that volunteering and meeting attendance remained fairly stable over the 5-year period, while employment declined over time among older adults. Caregiving showed a substantial amount of change over time.

Overall, the older adult sample in NSHAP was relatively well-equipped with human capital. More than two third of the sample received at least high school education and did not report any functional limitation. In terms of social capital, 62% of the sample was married. On average, respondents had about 3.5 friends in their core discussion network with whom they could discuss important matters. They also received an adequate amount of support from their

significant others (mean=1.42, SD=.43). Respondents were fairly frequent religious-service attenders; 46% of the respondents had attended church at least every week in the past year.

2.4.1 Predictors of Productive Activities

Table 2-2 displays the results for volunteering at W1 and W2. The first equation is a logistic regression of W1 participation in volunteering regardless of their frequency in activity, and the second equation predicts W2 maintenance in volunteering on a subsample of W1 volunteers. The cross-sectional analyses demonstrate that volunteering is influenced by all three forms of capital. Examining the participation of volunteer activity at W1 in the first equation, those with higher education (OR=1.58, p<.001), fewer functional limitations (OR=0.87, p<.001), bigger network size (OR=1.15, p<.001), greater social support (OR=1.52, p<.01), and more frequent religious service attendance (OR=1.45, p<.001) were more likely to be active volunteers. However, longitudinal analysis (equation 2) shows that only education (OR=1.41, p<.001) and religious service attendance (OR=1.28, p<.001) remain as significant predictors of continued volunteer activity. Among W1 volunteers, education and religious service attendance are associated with 41% and 28% greater odds of continuing the same activity, respectively.

<Table 2-2 about here>

The third and fourth equations show the results of ordinary least squares regression analyses for W1 and W2 volunteering frequency. Older adults with greater human, social, and cultural capital not only participated in W1 volunteer activity, but also dedicated more time in doing so. However, only education (b=0.18, p<.01) and religious service attendance (b=0.16, p<.001) exerted the effects in longitudinal analyses, adjusting for non-random selection effects and W1 volunteering frequency. The findings collectively suggest that volunteers are generally equipped with human, social, and cultural capital. Further, highly educated and religious older adults were more likely to be active as volunteers over the 5-year period. It is also noteworthy

that those who attend meetings more regularly are more likely to volunteer and do so more frequently at W2. Supplementary analyses revealed that employment or caregiving activity was not a significant predictor of volunteering.

Table 2-3 presents the findings for meeting attendance. As for volunteering, the first equation shows that education (OR=1.76, p<.001), functional limitations (OR=0.90, p<.01), network size (OR=1.13, p<.001), and religious service attendance (OR = 1.35, p<.001) were associated with W1 participation in meeting attendance. These predictors were also related to the frequency of activity at Wave 1. However, after adjusting for baseline level of meeting attendance and selection effects in longitudinal analyses, only education and religious service attendance remained significant. Among control variables, frequency of physical activity was a consistent positive predictor of meeting attendance in both cross-sectional and longitudinal analyses. Looking at the results for volunteering and meeting attendance together, the findings show that while individuals participating in these activities generally have more resources. Education and religious service attendance were consistent predictors that influenced both the baseline participation level and *changes* in the activities.

<Table 2-3 about here>

Table 2-4 shows the findings for employment. The first two equations show results from logistic regression estimating W1 and W2 employment status, and the third and fourth equations present findings from ordinal logistic regressions predicting W1 and W2 employment, while distinguishing part-time and full-time employment. The results indicate that employment is greatly influenced by human capital. At W1 (equation 1), education (OR=1.24, p<.001) and functional limitation (OR=0.75, p<.001) were associated with employment. Components for social capital and cultural capital did not predict the likelihood of paid work. Those who are older, female, Black, and other race were less likely to be employed. Turning to longitudinal analyses, among W1 workers, education was associated with 21% higher likelihood of continued

employment at the subsequent wave. The third equation shows that education (OR=1.21, p<.001) is positively associated, while functional limitation (OR=0.75, p<.001) and marital status (OR=0.80, p<.05) are negatively associated with being part-time and full-time workers compared to those who do not work. Among control variables, only female (OR=0.60, p<.01) remained significant in the longitudinal analysis.

<Table 2-4 about here>

Finally, Table 2-5 presents the findings on caregiving. At W1 (equation 1), married individuals were almost twice as likely as unmarried persons to provide care for adults with their day-to-day activities. Among W1 non-caregivers (equation 2), marital status (OR=1.61, p<.05), and network size (OR=1.17, p<.05) were positively associated while education (OR=0.79, p<.05) was negatively related to the *initiation* of caregiving. Though Black and female older adults were more likely to provide care at W1, such differences are attenuated in longitudinal analyses. The results from the ordinal logistic regression replicate those from binary logistic regression. The findings provide little evidence for the healthy caregiver hypothesis or role of cultural capital in predicting caregiving activity.

<Table 2-5 about here>

2.5 Discussion

Matilda White Riley, in her presidential address in 1986, recognized that the ideal type of age-integrated society offers role opportunities at work, in leisure and in education to people of *every age* (Riley, 1987). In response, the productive aging model was developed to promote the value of age-integrated society, specifically focusing on the prevalence, predictors, and consequences of productivity in later life. Building on this body of literature, the current study examined the role of human, social, and cultural capital in shaping four types of productive activities.

The strong effects of education as a form of human capital on productive activity indicate that these activities are the enterprise of individuals with human resources. Contrary to Sherraden's model (2001) depicted in Figure 2-1, where education exerts indirect effects through individual capacity such as health and time available, the findings from this study and others (Burr et al., 2002; McNamara & Gonzales, 2011) show that education plays an independent role in promoting productive activity in both cross-sectional and longitudinal analyses. Though older adults in the sample completed their education almost 30 to 40 years ago, education affected not only baseline participation in volunteering, meeting attendance, and employment, but also the long-term commitment in these activities over the 5-year period. As Durkheim (1925) asserts, higher education teaches students "how to act on behalf of the collective interests" (p. 59) and the values of thinking critically about social issues. As such, education remains a powerful predictor of multiple types of productive activities even in later life.

Another notable finding is the lack of relationship between Activities of Daily Living (ADL) and productive activities over time. Though functional limitations were associated with volunteering, meeting attendance, and employment at baseline, the relationship was attenuated in the longitudinal analyses. Such findings might be counterintuitive, especially given the extant literature on health and social activities in general. In order to shed light on these findings, several additional analyses were conducted. First, W2 productive activities were re-estimated using the *changes* in ADL (i.e., increase, decrease, no change) rather than baseline level along with other independent variables. The results show that an increase in functional limitations had no significant effect on productive activities except for employment. Further, analyses were conducted to test the possibility of mediation by which functional limitations affect baseline volunteering and subsequently influence W2 volunteering. However, the Sobel-Goodman test did not reveal significant mediation effects. Finally, since ADL assesses fairly severe limitations in physical functioning, I considered self-rated physical health instead. The results and

conclusions did not differ significantly from what are presented in the Tables. Taken together, the results from this project, along with other studies (Li & Ferraro, 2006; Musick & Wilson, 2007), support that the effects of health selection for older adults may not be as substantial as one might expect.

The effects of social capital exhibit less consistent pattern than that of human capital. Those with greater social capital generally participate more in productive activity –and volunteering in particular– but the effects are not apparent in the longitudinal analyses. Not surprisingly, married individuals were more likely to be caregivers and were likely to start providing care (possibly to their ill spouse). Network size is positively associated with volunteering and meeting attendance at W1, suggesting that individuals with bigger core network are generally exposed to more opportunities for these activities. Literature on volunteering supports that potential volunteers are usually recruited through social ties rather than impersonal advertisements (Wilson, 2000). The relationship between network size and volunteering/meeting attendance was attenuated in the longitudinal analyses.

Perhaps the most consistent and notable effects are from cultural capital, indicated by the frequency of religious service attendance. Those who attend religious service more regularly are more likely to be volunteers and meeting attenders than are less frequent service-goers. This underscores the role of cultural capital in recruiting and retaining older individuals into volunteering. Though some studies consider religious service attendance as a form of social capital, the current project adopted a view that religious organizations are not simply a set of social networks, but rather a cultural context that promotes collective actions and helps their parishioners internalize the cultural of benevolence (Lim & MacGregor, 2012). This echoes Robert Wuthnow's (1991) argument that these organizations teach values of giving back to the communities in their "churches, synagogues, fellowship halls, and meeting places … [and also]

command valuable resources for mobilizing people, turning their good intentions into concrete actions, so that the needy are actually helped" (1991, p. 284).

Testing the hypotheses regarding the social antecedents of productive activity leads to a number of important conclusions. First, it should be noted that human capital, which many scholars linked to a range of behavioral outcomes, is not the sole predictor of productive activity, *particularly over time*. Rather, older adults' activities occur in the context of human, social, and cultural capital. It is noteworthy that human capital (i.e., education) and cultural capital (i.e., religious service attendance) affect participation and frequency of volunteer activity and meeting attendance even after adjusting for non-random selection effects, other types of productive activity, and prior level of participation. Though previous studies have rendered notable findings on how resources shape one specific activity, cross-sectionally or over time, they also have acknowledged that failing to take into account selective survival (Bertrand et al., 2012), longer vectors of independent variables (McNamara & Gonzales, 2011), and changes in the activities over time (Choi, 2003) may lead to overestimation of the role of resources in predicting any productive activity of interest. The current study suggests that different patterns emerge in cross-sectional and longitudinal analyses of productive activity, adjusting for baseline activity level and attrition.

Second, the findings further demonstrate how individual and social factors influence productive activity differently, calling attention to studying multiple types of productive activities as much as focusing on a single activity. Some authors pioneer this trend by examining multiple productive activities at the same time, using a person-centered approach using latent class analyses (LCA) or a variable-centered approach employing exploratory factor analyses (EFA), in attempt to classify these types of productive activities and what factors predict these activities (Burr et al., 2007). Future research should focus on these profiles of activities as much as focusing on one particular activity in depth.

Several aspects of the study are novel, but the conclusions should be interpreted with caution due to some important study limitations. Studies on the trajectories of productive activity could benefit from adopting a longer view of social environments and behavioral outcomes that spans across middle and later life. Several studies document that different predictors influence productive activities for middle-aged and older adults (Li & Ferraro, 2006), signifying the need to study productive activity from a life course perspective. The current study took a step forward by using two-wave data from a nationally representative sample of older adults, but did not have any information on duration, timing, and previous experiences in productive activities (e.g., Did respondent volunteer at age of 16? How long were they employed? When did they start volunteering? Parental productive activity?). Investigating when and why individuals partake in productive activities will shed light on how one can create opportunities for older adults to participate in these activities, promoting healthier aging.

Further, though the current study focused on four types of important productive activity, a wide range of activities should be considered to capture a more comprehensive picture of older adults' activity profiles. Older adults undertake multiple roles and are active in these roles to varying degrees. Since some activities are complementary while others are not, investigating a wider array of activity patterns is as important as studying one activity in depth. Finally, the measure of cultural capital is limited. Religious service attendance is recognized as a valid proxy measure for the 'culture of benevolence' because religious organizations not only provide older adults with opportunities for contributing to the larger community but also promote values in helping others. Nonetheless, multiple or direct measures of cultural capital (e.g., values in 'being productive' or 'helping others') are preferred.

The analyses used participation and frequency of productive activities, but the measures could be improved further. For instance, respondents are asked if they volunteered in 'religious, charitable, political, health-related, and other organizations' for voluntary activity. However,

multiple forms of capital may affect volunteers who choose to work in health-related groups differently than those who volunteer in religious organizations. If the questions are more specific to the groups in which older adults decide to volunteer, one can examine questions such as whether human capital affects political volunteers more than religious volunteers or whether cultural capital exert effects on political, religious, and health-related volunteering differently.

In sum, the study adds to the literature by finding that human, social, and cultural capital affect productive activities differently, and suggests that scholars cannot simply assume that capital will be related to productive activities in a similar way across activities or over time. It is evident that some forms of capital predict the changes of the activity while other do not. The findings also suggest that studies that examine one form of capital (i.e., education) and a single activity of interest cross-sectionally may run a risk of overestimating the effects of capital on any activity in question. Further, some of these factors including social support, network size, and religious service attendance are relatively amenable to policy changes or community interventions, which can help older individuals to stay active and productive.

Table 2-1. Descriptive Statistics for Variables, NSHAP

	Range	Mean or Proportion (SD)
Productive Activities – W1 Participation		
Volunteering	0, 1	.63
Attend Meeting	0, 1	.69
Employment	0, 1	.30
Caregiving	0, 1	.17
Productive Activities – W1 Frequency		
Volunteering	0-6	2.14 (2.08)
Attend Meeting	0-6	2.58 (2.15)
Employment	0-2	.46 (0.75)
Caregiving	0-2	.21 (0.55)
Productive Activities – W2 Participation		
Volunteering	0, 1	.62
Attend Meeting	0, 1	.70
Employment	0, 1	.10
Caregiving	0, 1	.16
Productive Activities – W2 Frequency		
Volunteering	0-6	2.16 (2.13)
Attend Meeting	0-6	2.67 (2.17)
Employment	0-2	.22 (0.56)
Caregiving	0-2	.15 (0.48)
Human Capital		
Education	0-3	1.49 (1.07)
Functional limitations	0-18	.81 (1.89)
Social Capital		
Married	0, 1	.62
Network size	0-6	3.48 (1.59)
Support	0-2	1.43 (0.43)
Cultural Capital		
Religious Service Attendance	0-6	3.36 (2.11)
Demographic		
Age	57-85	69.30 (7.85)
Female	0, 1	.52
Black	0, 1	.17
Other Race	0, 1	.06
Depressive Symptoms (CES-D)	0-32	5.55 (5.19)
Life Style Factors		
Tobacco use (%)	0, 1	.15
Physical activity	0-4	3.11 (1.36)
Obese (BMI≥30 kg/m^2, %)	0, 1	.38

Notes: Sample size varies due to missing data. Mean values for binary variables reflect the proportion.

Table 2-2. Logistic Regression and Ordinary Least Squares Regression Predicting Volunteering, Wave 1 and Wave 2

	Participation (0, 1)				Frequency of Activity (0-6)			
	Wave 1 (n=2,259)		Wave 2 Maintainers (n=1,069)		Wave 1 (n=2,259)		Wave 2 Maintainers (n=1,069)	
	OR [a]	95% CI	OR [a]	95% CI	Coefficient [b]	SE	Coefficient [b]	SE
Human Capital								
Education	1.58***	1.42-1.75	1.41***	1.17-1.68	0.36***	.04	0.18**	.06
Functional Limitations	0.87***	0.81-0.93	1.07	0.91-1.25	-0.10***	.03	0.02	.05
Social Capital								
Married	1.10	0.88-1.37	1.35	0.92-1.97	-0.12	.09	0.22	.12
Network Size	1.15***	1.07-1.22	1.01	0.90-1.14	0.11***	.03	0.03	.04
Support	1.52**	1.19-1.95	1.13	0.72-1.78	0.34**	.10	-0.13	.15
Cultural Capital								
Religious Service Attendance	1.45***	1.38-1.52	1.28***	1.18-1.40	0.37***	.02	0.16***	.03
Age	1.01	1.00-1.02	0.98	0.94-1.02	0.01*	.01	0.01	.01
Female	0.96	0.78-1.19	1.02	0.70-1.49	0.07	.08	-0.04	.12
Black	0.97	0.73-1.28	0.99	0.58-1.70	0.07	.11	-0.13	.17
Other Race	0.68*	0.47-0.99	0.41*	0.21-0.81	-0.33*	.15	-0.29	.24
Depressive Symptoms	1.00	0.98-1.02	1.02	0.98-1.06	-0.02*	.01	-0.01	.01
Tobacco use	0.90	0.68-1.19	0.58*	0.35-0.97	-0.18	.11	-0.18	.10
Physical Activity	1.10*	1.01-1.19	1.15	0.99-1.35	0.06	.03	0.08	.05
Obesity	0.93	0.76-1.15	0.79	0.55-1.13	-0.02	.08	-0.13	.11
Selection λ			0.62	0.11-3.67			-0.77	.57
Wave 1 Meeting Attendance			1.50***	1.36-1.64			0.24***	.03
Wave 1 Volunteering							0.46***	.04
Constant					-1.41	.46	-0.52	.75
Pseudo R^2	.1761		.1797		--		--	
Adjusted R^2	--		--		.2503		.3425	

[a] Odds ratios are exponentiated coefficients based on logistic regression

[b] Unstandardized coefficients based on Ordinary Least Squares (OLS) regression

* p<.05, ** p<.01, *** p<.001

Table 2-3. Logistic Regression and Ordinary Least Squares Regression Predicting Meeting Attendance, Wave 1 and Wave 2

	Participation (0, 1)				Frequency of Activity (0-6)			
	Wave 1 (n=2,260)		Wave 2 Maintainers (n=1,152)		Wave 1 (n=2,260)		Wave 2 Maintainers (n=1,152)	
	OR [a]	95% CI	OR [a]	95% CI	Coefficient [b]	SE	Coefficient [b]	SE
Human Capital								
Education	1.76***	1.59-1.96	1.71***	1.43-2.05	0.49***	.04	0.32***	.06
Functional Limitations	0.90**	0.84-0.97	1.02	0.88-1.18	-0.10**	.03	0.03	.05
Social Capital								
Married	1.04	0.83-1.30	0.84	0.57-1.25	-0.15	.09	-0.19	.12
Network Size	1.13***	1.05-1.20	0.99	0.88-1.12	0.11***	.03	-0.01	.04
Support	1.13	0.88-1.46	1.41	0.88-2.24	0.17	.10	0.26	.14
Cultural Capital								
Religious Service Attendance	1.35***	1.28-1.42	1.20***	1.09-1.31	0.30***	.02	0.10***	.03
Age	1.01	0.99-1.02	1.02	0.99-1.06	0.01	.01	0.02	.01
Female	1.04	0.84-1.29	0.83	0.56-1.23	0.26**	.09	-0.08	.12
Black	1.36*	1.02-1.82	1.00	0.60-1.68	0.23	.12	-0.05	.16
Other Race	0.60**	0.41-0.86	0.56	0.29-1.08	-0.58***	.16	-0.34	.22
Depressive Symptoms	0.99	0.97-1.01	1.03	0.99-1.08	-0.02*	.01	0.01	.01
Tobacco use	0.80	0.61-1.06	0.89	0.52-1.51	-0.28*	.12	-0.29	.18
Physical Activity	1.13***	1.04-1.22	1.28**	1.10-1.49	0.12***	.03	0.14**	.05
Obesity	1.05	0.85-1.30	1.15	0.79-1.67	0.03	.09	0.10	.11
Selection λ			0.20	0.04-1.02			-1.30*	.56
Wave 1 Volunteering			1.32***	1.20-1.45			0.15***	.03
Wave 1 Meeting Attendance							0.41***	.04
Constant					-0.46	.49	-1.29	.77
Pseudo R^2	.1576		.1584		--		--	
Adjusted R^2	--		--		.2265		.2704	

[a] Odds ratios are exponentiated coefficients based on logistic regression

[b] Unstandardized coefficients based on Ordinary Least Squares (OLS) regression

* p<.05, ** p<.01, *** p<.001

Table 2-4**.** Logistic Regression and Ordered Logistic Regression Predicting Employment, Wave 1 and Wave 2

	Participation (0, 1)				Frequency of Activity (0-2)			
	Wave 1 (n=2,682)		Wave 2 Maintainers (n=728)		Wave 1 (n=2,682)		Wave 2 Maintainers (n=728)	
	OR [a]	95% CI	OR [a]	95% CI	OR [b]	95% CI	OR [b]	95% CI
Human Capital								
Education	1.24***	1.13-1.37	1.21*	1.04-1.42	1.21***	1.10-1.32	1.23*	1.05-1.44
Functional Limitations	0.75***	0.67-0.83	0.94	0.75-1.19	0.75***	0.68-0.82	0.84	0.66-1.08
Social Capital								
Married	0.81	0.65-1.01	0.84	0.58-1.22	0.80*	0.65-0.99	0.71	0.49-1.03
Network Size	0.97	0.91-1.03	1.02	0.91-1.13	0.97	0.91-1.03	1.04	0.94-1.16
Support	0.89	0.70-1.13	1.44	0.96-2.16	0.94	0.74-1.18	1.46	0.98-2.17
Cultural Capital								
Religious Service Attendance	1.03	0.98-1.08	1.04	0.97-1.13	1.04	0.99-1.09	1.06	0.99-1.15
Age	0.88***	0.86-0.89	1.00	0.96-1.04	0.86***	0.85-0.88	0.97	0.93-1.01
Female	0.60***	0.49-0.73	0.71	0.50-1.02	0.54***	0.44-0.65	0.60**	0.42-0.85
Black	0.66**	0.51-0.86	0.81	0.51-1.27	0.61***	0.47-0.78	0.73	0.46-1.15
Other Race	0.95	0.67-1.34	0.80	0.47-1.39	1.05	0.76-1.46	0.86	0.50-1.47
Depressive Symptoms	0.95***	0.93-0.98	0.99	0.95-1.03	0.95***	0.93-0.97	0.99	0.95-1.03
Tobacco use	0.77	0.57-1.01	0.83	0.50-1.38	0.80	0.62-1.04	0.83	0.49-1.39
Physical Activity	1.01	0.93-1.10	0.93	0.80-1.08	0.98	0.90-1.06	0.94	0.81-1.09
Obesity	1.19	0.98-1.45	0.85	0.62-1.16	1.19	0.99-1.43	0.91	0.67-1.24
Selection λ			0.13	0.01-1.41			0.10	0.01-1.28
Wave 1 Caregiving			1.01	0.65-1.58			0.81	0.45-1.44
Pseudo R^2	.1846		.0397		.1694		.0491	

[a] Odds ratios are presented based on binary logistic regression
[b] Odds ratios are presented based on ordinal logistic regression
* p<.05, ** p<.01, *** p<.001

Table 2-5. Logistic Regression and Ordered Logistic Regression Predicting Caregiving, Wave 1 and Wave 2

	Participation (0, 1)				Frequency of Activity (0-2)			
	Wave 1 (n=2,116)		Wave 2 Initiators (n=1,608)		Wave 1 (n=2,116)		Wave 2 Initiators (n=1,608)	
	OR [a]	95% CI	OR [a]	95% CI	OR [b]	95% CI	OR [b]	95% CI
Human Capital								
Education	1.05	0.92-1.20	0.79*	0.65-0.96	1.05	0.92-1.19	0.79*	0.65-0.96
Functional Limitations	0.94	0.85-1.04	0.98	0.81-1.18	0.94	0.85-1.05	0.98	0.81-1.19
Social Capital								
Married	1.90***	1.41-2.57	1.61*	1.01-2.60	2.00***	1.48-2.69	1.66*	1.03-2.67
Network Size	1.01	0.93-1.10	1.17*	1.02-1.34	1.01	0.93-1.10	1.17*	1.02-1.34
Support	1.08	0.78-1.51	1.04	0.61-1.75	1.04	0.75-1.45	1.03	0.61-1.74
Cultural Capital								
Religious Service Attendance	1.00	0.94-1.07	1.03	0.93-1.13	1.00	0.94-1.06	1.03	0.93-1.13
Age	1.00	0.98-1.02	1.02	0.98-1.07	1.00	0.98-1.02	1.03	0.98-1.07
Female	1.71***	1.31-2.24	0.87	0.56-1.35	1.74***	1.33-2.27	0.87	0.56-1.36
Black	2.04***	1.45-2.87	1.31	0.72-2.41	1.99***	1.42-2.79	1.30	0.71-2.38
Other Race	0.66	0.37-1.19	1.13	0.53-2.40	0.66	0.36-1.18	1.12	0.53-2.37
Depressive Symptoms	1.02	0.99-1.05	0.97	0.93-1.02	1.02	0.99-1.05	0.97	0.93-1.02
Tobacco use	0.87	0.59-1.28	1.30	0.70-2.40	0.89	0.60-1.31	1.32	0.72-2.45
Physical Activity	1.06	0.95-1.19	1.00	0.84-1.20	1.06	0.94-1.18	1.01	0.84-1.20
Obesity	0.96	0.74-1.25	1.18	0.79-1.78	0.94	0.72-1.23	1.18	0.78-1.77
Selection λ			0.28	0.04-1.86			0.27	0.04-1.77
Wave 1 Employment			1.02	0.77-1.35			1.02	0.77-1.34
Pseudo R^2	.0289		.0271		.0233		.0235	

[a] Odds ratios are presented based on binary logistic regression
[b] Odds ratios are presented based on ordinal logistic regression
* p<.05, ** p<.01, *** p<.001

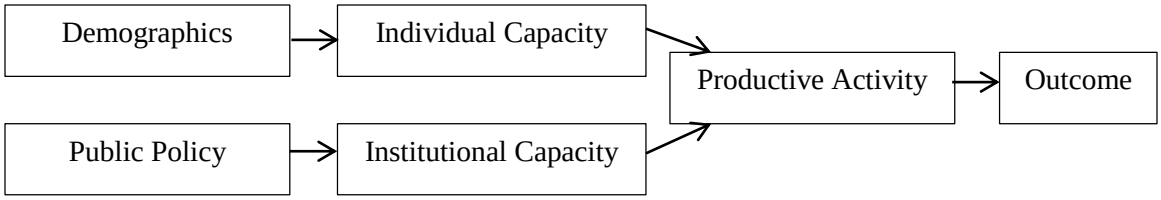

Figure 2-1. The Sherraden et al. (2001) model of productivity in later life

CHAPTER 3. DO PRODUCTIVE ACTIVITIES REDUCE INFLAMMATION IN AMERICAN AND KOREAN OLDER ADULTS?

3.1 Abstract

Objectives. The primary goal for the current project is to investigate the impact of multiple productive roles on chronic inflammation among older adults residing in the U.S. and Korea. **Method.** Using nationally representative data of the U.S. older adults aged 65 and older, the project examined the protective effects of productive activity against inflammation, measured by C-reactive protein (CRP), as a modifiable and objective health outcome. The analyses were then replicated on a Korean dataset to explore if the effects were comparable in both populations. **Results**. There were no statistically significant lagged effects of productive activity in 2005 on chronic inflammation in 2010, adjusting for the baseline covariates and initial CRP levels. When changes in the activity were modeled, however, maintaining the meeting attendance activity between the two waves was associated with a slower rate of increase in inflammation even after adjusting for baseline CRP levels, and the effect was stronger for male than female respondents. **Discussion.** The finding takes a step towards advancing the research of health benefits of productive activity by finding a gender-specific effect of productive activities (employment and meeting attendance) on chronic inflammation in longitudinal panel data. The project also calls attention to a more nuanced understanding of adults partaking in multiple roles to varying degrees. Moreover, the results suggest the need for health intervention and research designed to promote and maintain productive activity with explicit attention to potential gender differences.

Key words. Productive aging. Acute-phase protein. Chronic inflammation.

3.2 Introduction

Are there health benefits of productive activity? The extent to which older adults are active in their community has been a central interest in societies with a growing number of older adults as it directly relates to their quality of life (Riley & Riley, 1994; Siegrist & Wahrendorf, 2009). Bass and Caro, who coined the term *productive activity*, argued that older adults make both market and non-market contributions that generate substantial, though commonly overlooked, returns to the commonweal (Bass & Caro, 1995). Scholars also expounded whether and in what ways the participation benefits those who give back to the community (Baker, Cahalin, Gerst, & Burr, 2005; Morrow-Howell et al., 2001). Much of this inquiry is based on role theory, as it posits that assuming roles becomes sources of power, prestige, and resources, which subsequently lead to several health benefits for the individuals. Further, the positive meanings such as generativity and emotional gratification attached to productive activity may be more salutary than the case for other roles (Gruenewald, Liao, & Seeman, 2012). Thus, it is not surprising that various types of productive activity generally exert positive effects on health outcomes and prevent diseases in older persons (Hao, 2008; Li & Ferraro, 2006).

Despite extensive scholarly interest on health benefits of productive activity, most studies rely on self-reported measures of health or disease that can be influenced by respondents' contemporaneous psychosocial states or access to healthcare. If productive activity is an important component of older adults' well-being, the effect may well extend to biological risk factors that are linked to major chronic diseases. Among these biological markers, chronic inflammation is considered of major importance for the development of age-related diseases such as cardiovascular diseases and cancer, the first and second leading causes of death in America (Center for Disease Control and Prevention, 2014). Though acute inflammation is the body's natural defense against infections and toxic stimuli, chronically elevated inflammatory markers signal an early physiological dysregulation preceding diseases (Crimmins & Vasunilashorn,

2011). Further, available data indicate considerable heterogeneity and modifiability in inflammation among older adults. Research found that social relationships, productive activity, and even macro-level community environments modulate the secretion of proinflammatory cytokines, albeit using cross-sectional data (Kiecolt-Glaser, Gouin, & Hantsoo, 2010; Kim & Ferraro, 2014). Using longitudinal panel data of older adults in the U.S., the current study investigates whether participation and changes in productive activity predict chronic inflammation, measured by C-reactive protein (CRP).

Productive aging is accepted as beneficial in American society, but the question still remains if the same model could or should be emulated in other cultures. Thus far, most research on productive activity focuses on American older adults' experiences, warranting comparative investigations between the U.S. and other aging societies. For instance, in South Korea, the most rapidly 'greying' society due to rising life expectancy coupled with low fertility, productive activity among older adults received unprecedented attention in literature as well as the media. This is evident from the proliferation of Korean academic articles that include 'productive aging' or 'productive activity' from 3 in 2002 to 93 in 2014. However, little is known whether productive activity yields similar health benefits in older adults between American and Korean societies. Employing both American and Korean older adult samples, the current project examines the salutary effects of productive activity on inflammation.

The current study expands the literature on productive activities in at least three important ways. First, through studying inflammation as a modifiable and objective health outcome, the current study provides an important and understudied pathway underlying productive activity and health. It also encourages effective interventions one might use to influence older adults' health before chronic disease manifests as an enduring and costly problem. Second, the longitudinal analysis with the U.S. sample will provide fresh insights into how changes in productive activities influence chronic inflammation. Third, the analyses between two

datasets in the U.S. and Korea not only add convincing evidence to the benefits of productive activity but also supplement the traditional productive aging model with an explicit attention to different cultural contexts.

3.2.1 Productive Activities and Inflammation in Later Life

What might explain the generally positive influence of productive activities on older persons' well-being? Role theory stipulates that roles are generally beneficial for individuals. A role is defined as a set of expected behaviors within a specified social structure (Biddle, 1979). Individuals occupy multiple roles simultaneously throughout the life course and obtain evaluations of themselves as competent social actors through taking these roles (Adelmann, 1994; Biddle, 1979). Roles may be particularly beneficial for older adults as they experience role reduction that is often irreversible (e.g., empty nest, widowhood, retirement) and not easily amenable to substitution (Adelmann, 1994). Voluntary roles such as attending organized meetings or volunteering provide individuals with opportunities to partake in a meaningful role and remain active in later life (Thoits, 2012). Health benefits from such roles also may accrue from the meaning attached to them, including status, influence, and emotional gratification (Moen et al., 1992). Four roles for productive activity are examined in this project: volunteering, meeting attendance, caregiving, and employment.

Empirical research generally reports positive effects of productive roles in older adults on an array of health outcomes. Volunteering is positively associated with well-being, whether the considered outcome is self-rated health (Lum & Lightfoot, 2005), depressive symptoms (Li & Ferraro, 2005), or hypertension (Tavares, Burr, & Mutchler, 2013). Van Willigen (2000) used prospective data and suggested that older volunteers are more likely than younger ones to reap additional health benefits on life satisfaction per hour of participation. Further, the relationship between hours of volunteering and life satisfaction was linear among older adults aged 60 and

older but curvilinear among younger adults. The findings are in line with a study reporting age-specific effects of volunteering on depressive symptoms (Musick & Wilson, 2003). A cross-national evidence comes from research by Kumar and colleagues in 139 countries (2012), suggesting that volunteers report better self-rated health regardless of cultural, economic, and geographic settings. Paid employment has similar health-promoting effects for older adults, in that working adults show virtually no decline in self-rated health and physical functioning, albeit that healthier people are also more likely to be employed (Ross & Mirowsky, 1995). It may be that healthy individuals are selected into employment and subsequently get even healthier. Interestingly, Hao (2008) investigated both paid work and volunteer activity and demonstrated that older men and women who participate in single or double activity experienced slower rate of mental health decline than non-participants.

Though studied less frequently, community engagement is another type of productive activity that manifests a positive effect on health. Burr and colleagues (2002) argue that middle-aged and older adults who are strongly attached in a local community often attend organized meetings; the authors noted that "one form of activity understudied by analysts interested in productive activity is civic participation," and it is "a critical form of community involvement" (p. 88). As such, frequent meeting attendance is shown to predict positive health outcomes and prevent disability or cognitive declines in both male and female older adults (Mendes de Leon, Glass, & Berkman, 2003). Finally, caregiving is an important form of productive activity (Burr et al., 2002; Hinterlong, 2008; Matz-Costa et al., 2014). Estimates reported in 2009 show that the contribution of unpaid caregiving generated 450 billion dollars in 2009 for the nation and for care recipients (Feinberg, Reinhard, Houser, & Choula, 2013). A substantial body of research focuses on caregiver's depression and physical health problems (for a review, refer to Pinquart & Sorensen, 2003) but some studies also suggest that caregiving behaviors may improve adults' well-being (Brown, Nesse, Vinokur, & Smith, 2003). Moen and colleagues (1992) found no

direct effects of concurrent or past caregiving on health. Such inconsistent findings may be attributed to the heterogeneity within the caregiver group in terms of their relationship with the care recipients, intensity of involvement, and other activities outside the context of caregiving.

Although previous research has provided rich evidence on productive activities and health, most of these studies focus on single measurement for an activity predicting a health outcome. This strategy does not capture the heterogeneity within the group over time. Take volunteering, for example. Older adults with prolonged volunteer activity represent a different group of individuals in terms of health and activity profile than short-term volunteers. Studies that include a single measure in time consider these two types of volunteers in the same category, which may bias the purported health benefits of continued volunteer activity compared to temporary activity. Further, there might be a selection process by which productive older adults are more likely to remain in the study over time. To date, there are only a few studies (Li & Ferraro, 2005; Thoits & Hewitt, 2001) that have systematically examined such selection processes. Thus, I pay explicit attention to changes in productive activity and health in the U.S. sample while taking into account possible selection processes present in longitudinal data.

The current project, while informed primarily by sociological theories and empirical research outlined above, is distinct in that it employs biopsychosocial approach by studying a marker of inflammation. For years, self-reported measures garnered important information on the link between productive activity and health. However, self-reports of health or physician-diagnosed diseases may be greatly influenced by access to healthcare, psychosocial resources, and social desirability bias. Riley and Bond (1983) points to the significance of research on productive activity integrating biological or physiological markers that are harbingers for chronic disease outcomes, as elaborated. Among biological risk factors, I specifically examine chronic inflammation for two important reasons. First, an emerging body of literature establishes chronic inflammatory markers as potential tools to predict disease risks and all-cause mortality (Crimmins

& Vasunilashorn, 2011; Ridker, Kennekens, Buring, & Rifai, 2000; Sesso et al., 2003). Inflammation is a form of non-specific immune response that directs components of the immune system to a site of injury or infection (Sesso et al., 2003), and is 'turned off' when an illness is resolved. However, as the word inflammation in Latin loosely translates into 'to set on fire' or 'ignite,' chronically elevated inflammation is detrimental and linked to various pathological outcomes. In the case of cardiovascular diseases, chronic inflammation contributes to the development of atherogenesis (plaque formation in the inner lining of arteries) by reducing vascular endothelial cells' capacity to resist white blood cell adhesion (Bennett, Gillie, Lindgren, Fagundes, & Kiecolt-Glaser, 2013). A meta-analysis for 22 prospective studies found that coronary heart disease was predicted with an odds ratio of 1.58 for the upper tertile compared to the lowest tertile of CRP level (Danesh et al., 2004). Inflammation also plays a role in cancer progression by promoting cancerous cells' uncontrolled growth and metastasis. In this regard, chronic inflammation indicates physiological dysregulation preceding major diseases (Crimmins & Vasunilashorn, 2011).

Second, research shows that chronic inflammation is modifiable through enhancing social environments for older adults. Recent studies propose that social integration (Jaremka et al., 2013; Shankar, McMunn, Banks, & Steptoe, 2011), physical activity (McDade, Hawkley, & Cacioppo, 2006), and leisure activities (F. Lin, Friedman, Quinn, Chen, & Mapstone, 2012) lower inflammatory cytokines including CRP, IL-6, and fibrinogen. A study by Kim and Ferraro (2014) adds to this body of research, showing that multiple roles for productive activities, and frequent volunteering in particular, is associated with lower inflammation in older adults. Taken together, studies demonstrate that productive activities over time may 'get under the skin' and exert salutary effects. If the link exists, productive activities may be a palpable way to prevent the onset and development of chronic diseases.

3.2.2 Cross-Cultural Comparison

With increasing life expectancy, the role of older adults and the policies that promote productive activity become important issues around the globe. In particular, the Asia Pacific region contains approximately 50% of the world's population over age of 60. South Korea is the most rapidly 'greying' country in the world, from 7% of adults 65 and older in 2000 to 14% in 2020 (Kim et al., 2007). More importantly, due to a low fertility rate in Korea, the dependency rate –number of younger adults supporting one older person– is expected to increase rapidly. Such dramatic population aging makes productive activity a particularly timely issue for investigation. Several studies conducted in Korea demonstrate that older adults receive strong respect from the members of the community and maintain a valued status through productive contributions, which lead to positive health outcomes such as greater physical functioning (Park & Lee, 2007), life satisfaction (Kim, 2007), and psychological well-being (Cha & Seo, 2010). These findings lead to a testable hypothesis that both Korean and American older adults reap health benefits from productive activities. The Korean and U.S. datasets used in the current study contain comparable measures of health outcome as well as productive activities in older adults. If the findings are comparable, cross-cultural data on productive activity and inflammation will add convincing evidence that the productive aging model applies to different cultures other than the U.S. sample. The current study offers cross-cultural comparison by replicating analyses in comparable Korean and American datasets, privileging inflammation as a main physical health outcome.

3.3 Method

The project used the first and second waves of data from the National Social Life, Health and Aging Project (NSHAP) as well as the cross-sectional data from the Korean Social Life,

Health, and Aging Project (KSHAP). The NSHAP is an ongoing national representative longitudinal study of 3,005 older adults in the United States. NSHAP W1 was collected in 2005-2006 and comprised of older adults aged 58 and older. The initial response rate was 75%. During the interview, a random 83% sample (n=2,494) was selected for blood spot collection, of which 2,120 respondents agreed to provide samples (85% response rate). Additional 181 cases were discarded due to insufficient volume of blood or equipment malfunctions. Williams and McDade (2009) document that those who did not provide blood spot samples were not different from those who agreed by age, gender, race, income, education, marital status, self-rated health, and number of doctor visits in the past year. As is standard in the literature, 209 cases with very high levels of CRP (>8.6 mg/L), indicative of inflammatory response to acute conditions (e.g., flu, injury) were excluded (Herd, Karraker, & Friedman, 2012). By 2010-2011, when W2 data were collected, 220 respondents had died; 88 were in poor health or in a care facility; and an additional 94 respondents were not interviewed due to various reasons including refusal or lack of contact information. The final analytic sample size for the analysis is 1,161.

The KSHAP recruited the entire population, not a sample, of adults aged 60 years and older and their spouses residing in one township in Gangwha Island, South Korea in 2011-2012. This township is a typical rural Korean village where farming is the main source of livelihood, with the total population of 1,864 residents in 871 families as of January 2013 (Lee et al., 2014). Of the entire population, 860 (approximately 46%) are older adults aged 60 and older. Gangwha Island is a suitable site for the current investigation because rural areas represented by this township typically have a much higher proportion of older adults compared to the national average (12.7% in South Korea in 2014). Older residents in rural communities also have a stronger sense of community and engage in more mutual help or productive activities, as described by Durkheim's concept of gemeinschaft (Durkheim, 1951). Of the entire 860 eligible older adults, 814 agreed to participate in face-to-face interview (94% response rate) all of whom

were also invited to participate in health examination at the local public health center. Approximately 86% of KSHAP interview participants went through the health examinations (Lee et al., 2014), resulting in the final sample of 698. For detailed information on sampling procedure and health examinations, refer to Lee et al. (2014).

3.3.1 Measures

Dependent Variable: CRP Concentration. In NSHAP, during the face-to-face interview at both waves, a blood sample was collected via capillary finger stick and disposable lancet; up to five drops of blood were applied to filter paper for transport and storage. Blood-spot assays were completed at the Laboratory for Human Biology Research at Northwestern University (Williams & McDade, 2009). In KSHAP, all health measurements, including CRP, were collected in the local public health center. Blood sample were collected from the antecubital vein after at least an 8-hour fast. Samples were then analyzed at a central research laboratory at Yonsei University (Lee et al., 2014). CRP measured via dried spots is highly correlated with matched plasma samples, thus, quite comparable (r=0.96, McDade, Burhop, & Dohnal, 2004). Given the positively skewed distribution of CRP (few individuals have higher levels of CRP), the values were natural log transformed. Higher levels of CRP indicate more chronic inflammation, and worse physiological functioning.

Independent Variables: Productive Activity. Four productive activities were measured: volunteering, attending meetings, employment, and caregiving. In NSHAP, each of the measures is available in the analytic sample at both W1 and W2, which enables the assessment of the changes across two waves. The frequency of activity at baseline was measured by items asking respondents how often they participate in each activity. For *volunteer* activity, respondents were asked how often they volunteered for religious, charitable, political, health-related, and other organizations in the past 12 months. Responses ranged from never (0) to several times a week

(6). Using the same answer categories as for volunteering, respondents were also asked how often they attend organized meetings. *Meeting attendance* is used as an indicator of community involvement (Burr et al., 2002). For *employmen*t, respondents reported the number of hours they typically work during a week. I defined those who work 40 hours or more a week as full-time workers. Additional analyses examined alternative threshold for full-time employment (e.g., 35 hours), but the conclusions were unchanged. Finally, respondents were asked whether they are currently assisting an adult who needs help with day-to-day activities due to age or disability. If answered yes, they were then asked how many days per week they typically spend caring for this person. The original response ranged from 0 to 7 days. However, because not many respondents reported 1 to 6 days of caregiving, I created three categories for no care (coded 0), part-time (1), and full-time (2) *caregiving*. In order to assess changes in productive activity, three categories were included for increase (if activity frequency at W2 is greater than W1), decrease, and maintenance of any given activity. No activity served as a reference group. In KSHAP, three activities were available: volunteering, meeting attendance, and employment. During the interview, the respondents were asked if they either participated in the activity or not. Compared to NSHAP measures of frequency, it is quite easier for older adults to answer the questions on status rather than frequency of participation in various activities, but one loses the heterogeneity within the participatory group (i.e., those who answered 'yes' to any given activity) by using a binary indicator. Caregiving item was not included in the original questionnaire, possibly because Korean older adults are primarily care recipients rather than caregivers.

Additional Covariates. In addition to the variables of central interests, several covariates were considered in both datasets because of their relationships with chronic inflammation (Herd et al., 2012; Kim & Ferraro, 2014). In NSHAP, all covariates were measured at W1. *Age* is coded in years, and sex is dichotomized with 1 indicating *female*. Race was divided into a series of binary variables (*White, Black*, and *other race*) with non-Hispanic White serving as a reference

category. Other race consisted of American Indian or Alaskan Native, Asian or Pacific Islander, and those who identified themselves as other race. Marital status is a binary variable with 1 indicating *married* or cohabiting with a partner. In order to measure socioeconomic status, four categories of *education* (less than high school, high school graduate, some college, and bachelor's degree or more) and *low net worth* were included in the analysis. Respondents were asked to estimate their net worth including all of their investment, properties, and other financial assets minus debt. A binary variable was created distinguishing respondents in the lowest 20% of the household net worth from those in the top 80%.

For health-related life style factors considered to predict CRP, I used self-reported information. *Tobacco use* was defined by current consumption of cigarettes, pipes, cigars, or chewing tobacco. *Physical activity* was measured with an item probing respondents' frequency of physical activities such as walking, dancing, or exercise (0-never, to 4-three or more times per week). Binary variable for *obesity* was defined by calculating body mass index with interviewer-measured height and weight ($> 30 kg/m^2$). *Depressive symptoms* were based on the 11-item Center for Epidemiologic Studies Depression Scale (CES-D) (Chronbach's $\alpha = .80$). Finally, the analysis adjusts for clinically relevant chronic health conditions in order to alleviate concerns for reverse causality in the productive activity-CRP relationship. Respondents were identified as having a condition if they were ever diagnosed by a physician for *emphysema, asthma, and diabetes*. Further, given a documented inverse relationship between lipid-lowering treatment and CRP (Ridker et al., 2000), a binary variable for *lipid medication* use was included in the analyses.

I attempted to keep the variables and their coding algorithms as consistent as possible between the two datasets for the purpose of comparison. Nevertheless, some variables are different. In KSHAP, racial categories are not applicable. Since the majority of Korean respondents did not receive college education, education includes three categories instead of four (less than high school, high school, college or more). For low net worth, I used the same

procedure as in NSHAP to identify the lowest 20% on the wealth distribution. The original items for depressive symptoms were based on 20-item CES-D scale, but only 11 items that are consistent with the NSHAP measures were included in the analyses (Chronbach's α for 11-item CES-D= .82). There were no available measures of respondents' physical activity or emphysema. All other covariates and their coding schemes are consistent with the NSHAP data.

Supplementary analyses considered additional covariates (e.g., income, controlled and uncontrolled hypertension, former smoking, underweight, overweight, religious service attendance, and self-reported physical/mental health) and alternative coding of variables (e.g., continuous measure of net worth, number of days for caregiving frequency). These were omitted from the final analyses, however, because they did not make significant changes to the conclusion in any of the multivariate specifications.

3.3.2 Analyses

The analyses used ordinary least squares (OLS) regression to model the initial level of CRP (W1) as well as the changes in CRP (by regressing W2 CRP on W1 CRP) in NSHAP. The first set of analyses examined cross-sectional relationship between W1 productive activities and W1 CRP. In the longitudinal analyses, W1 activities were included in the models specified as lagged predictors of W2 CRP. Another type of longitudinal analysis investigated changes in the productive activities between waves predicting CRP at W2. The final analysis attempts to replicate the analyses in NSHAP with the cross-sectional KSHAP data.

In NSHAP, re-interview rates were high in the follow-up study (i.e., 87.8% of the NSHAP W1 survivors were re-interviewed) but sample attrition may nonetheless produce biased parameter estimates in longitudinal analyses. Since the majority of attrition was due to death, Heckman's (1979) selection bias models were employed to adjust for the differential selectivity due to mortality. I first estimated a probit model to distinguish respondents who participated at

the follow-up interview from those who died. Predictors of mortality in the probit model included age, female, and tobacco use along with several variables that were *not* in the substantive equation predicting CRP (i.e., difficulty in activities of daily living (ADL), underweight (BMI $\leq$ 18.5), and self-rated health). The selection instrument (λ) based on the inverse Mills ratio was subsequently estimated and included in the substantive regression models.

3.4 Results

Table 3-1 illustrates the descriptive statistics for the variables used in the analyses in NSHAP and KSHAP. In NSHAP at baseline, the average log CRP level was 0.12 (raw CRP=1.82), indicating a normal range ($\geq$ 3 mg/L for a high level of chronic inflammation). Mean levels for volunteering and meeting attendance activity were 2.37 and 2.90 respectively, which translate into between several times a year and once a month. About 12.5% of the respondents were caregivers and 8% were full-time caregivers. About 17% of the sample was employed part-time, while 18% worked full-time. At Wave 2 in 2010, the average log CRP level was somewhat higher at 0.53 (raw CRP=2.46). The average levels of volunteering, meeting attendance, and caregiving did not show a drastic decrease. However, employment decreases with 14% part-time and 7% full-time employees.

<Table 3-1 about here>

In KSHAP, mean log CRP value among older adults was -0.12 (raw CRP=1.36). Thirteen per cent of older adults in KSHAP were active as volunteers, 27% as meeting attenders, and 68% as workers. Among other variables, significant differences emerged between the Korean and American samples in terms of age, proportion of female respondents, marital status, obesity, depressive symptoms, and lipid medication use. In particular, only 4% of the entire sample in KSHAP was obese while 38% of older adults in NSHAP were classified as obese.

Productive Activities and Chronic Inflammation: Main Effects ModelsTable 3-2. displays the results from the OLS regression with W1 productive activities specified as lagged predictors of W2 log CRP in NSHAP. Contrary to the proposed hypotheses, no productive activities at W1 exerted significant effects on W2 CRP. Supplementary analyses (tables not shown) revealed that the link between volunteering and CRP is significant in the baseline model but is attenuated once the model adjusts for obesity and W1 CRP. As expected, obesity and W1 CRP were positively associated with W2 CRP (Schafer, Ferraro, & Williams, 2011).

<Table 3-2 about here>

Considering continued participants in productive activity and temporary ones in the same category may be dismissive of the heterogeneity within the group. Thus, I posed a specific question on changes in productive activity and CRP, assuming that older adults participate in productive activities to varying degrees over time. Table 3-3 shows the findings from OLS regression with changes in productive activity predicting log CRP at W2. Each equation includes separate indicators for increase, decrease, and maintaining the given activity with no activity serving as a reference group. W2 CRP is the outcome for each equation. The findings reveal that maintaining the meeting attendance activity is associated with lower CRP even after adjusting for baseline levels ($b=-0.18$, $p<.05$). Similar with findings presented in Table 3-2, obesity and W1 CRP were consistent and strong predictors of W2 CRP.

<Table 3-3 about here>

3.4.1 Productive Activities and Chronic Inflammation: Gender and Age Stratified Models

Given the documented gender- or age-specific health benefits of productive activities (Herzog et al., 1989; Simon, 1995; Van Willigen, 2000), I conducted supplementary gender and age stratified analyses. There were no age-specific effects, but I found gender differences among American older adults. For meeting attendance, male respondents reaped additional benefits from

maintaining meeting attendance activity during the 5-year period (b=-0.29, p<.05). Interestingly, increasing employment activity for male older adults in NSHAP was associated with an increase in CRP (b=0.45, p<.05), while there was no such effect on women. Figure 3-1and Figure 3-2 graphically depicts gender differences in meeting attendance and employment. The results from the gender-stratified analyses are presented in Appendix I.

3.4.2 Replicative Analyses in NSHAP and KSHAP

Finally, Table 3-4 presents the findings from the cross-sectional analyses of the relationship between productive activity (measured with binary variable for volunteering, meeting attendance, and employment) and log CRP in Korean older adults. To aid the comparison between KSHAP and NSHAP, I created binary variables for productive activity in W2 NSHAP and conducted the same analyses. I used W2 NSHAP because the data were collected at the same time in 2012 as for KSHAP. The first column presents the findings from KSHAP. The analyses did not yield significant findings for productive activities. In KSHAP, female respondents exhibited substantially lower CRP than their male counterparts (b=-2.38, p<.01) and current tobacco users reported higher CRP than non-smokers (b=2.30, p<.01) adjusting for other covariates. The second column shows the findings from replicative analyses using W2 NSHAP. The results reveal no significant findings for binary indicators of productive activity on log CRP at W2, consistent with KSHAP findings. Among covariates, female, Black, tobacco use, obesity, and lipid medication use exerted significant effects.

<Table 3-4 about here>

3.5 Discussion

The primary goal for the current project was to investigate the impact of multiple types of productive activities on chronic inflammation among older adults residing in the U.S. and in

South Korea. The study is novel in that it uses longitudinal panel data from older adults in the U.S., and replicates the analyses in the comparable Korean dataset. Both the W1 productive activities (as lagged predictors) as well as changes in the activities were examined. This is pertinent because older adults typically change the frequency of their activities over time to meet their needs or to maintain optimal well-being. To my knowledge, the current project is the first to systematically address these issues.

The first set of findings in American older adults show that there are minimal lagged effects of productive activity at W1 on chronic inflammation at W2, adjusting for the W1 covariates and CRP levels. Given the literature on a strong relationship between productive activity and health, I expected a moderate to strong link between productive activities and CRP. However, the results appear to contradict the extant research documenting general health benefits of productive activity (Glass, Mendes de Leon, Bassuk, & Berkman, 2006; Kim & Ferraro, 2014; Matz-Costa et al., 2014). One possible explanation is that the lagged effects of productive activity may be outcome-specific. Previous research shows that volunteering activity prevented a decrease in quality of life, though it was not associated with an improvement (Siegrist & Wahrendorf, 2009). A different study suggests that volunteer activity is predictive of happiness and better physical functioning, not life satisfaction, during the 6-year follow-up (Menec, 2003). Interestingly, a study found that hours of productive activity comprised of volunteering, caregiving, paid work, informal assistance, and do-it-yourself activity are related to improved life satisfaction and happiness but not to depressive symptoms (Baker et al., 2005). In a comparative study between the U.S. and Taiwan, social integration (included respondents participating in social groups) was related to lower CRP in Taiwan, but not in the U.S (Glei, Goldman, Ryff, Lin, & Weinstein, 2012). The findings point to the need for investigating which health outcomes are positively influenced by the participation in productive activity, including biological risk factors.

Another plausible explanation is that productive activity may exert lagged effect through an intermediate outcome such as health-promoting behaviors or chronic conditions that are not captured in the analyses. As briefly mentioned in the results section, it is worth noting that volunteering was a significant predictor of W2 CRP in the baseline models with volunteering and demographic control variables, yet the impact was reduced to statistical non-significance after adjusting for obesity and baseline CRP levels. The study has implications for future studies focusing on specific domains of health on which productive activities are beneficial as well as the potential pathways linking them together.

When the changes in the activity were examined, maintaining the meeting attendance activity between the two waves was associated with a slower rate of increase in chronic inflammation even after adjusting for the baseline CRP levels, and the effect was larger for male than female respondents. Results show that men have more affinity for certain activities than do women, which translates into differential distribution of health benefits between the two groups.

Maintaining community ties in the form of meeting attendance may be beneficial for men because they have more positive attachment to the role than do women. Women also have a greater degree of other role involvement outside the context of productive activity (Burr et al., 2007; Simon, 1995). Further, increasing employment activity between the waves was associated with an increase in CRP among men but not among women. The negative implications for an increase in employment on CRP in men may be attributed to the financial strain. In fact, the majority of respondents in NSHAP who increased work moved from no work to part-time employment, which could be indicative of financial hardship associated with the changes. In prospective data, part-time work, compared to full-time employment, is associated with less health-promoting behaviors (e.g., checking the labels on medicine, exercise, wearing seatbelts) among older adults (Macy, Chassin, & Presson, 2013). Thus, changes in employment rather than static measures reveal gender-specific implications for health.

The findings from KSHAP and replicative analyses in NSHAP show no significant results of productive activity on chronic inflammation. The binary measures of productive activity did not show any significant effects on CRP in either NSHAP or KSHAP samples as shown in the first and second columns of Table 3-4. Ordinary Least Squares Regression Predicting Log CRP, KSHAP and NSHAP. However, the same analyses in NSHAP but with the frequency of activity instead of a status, revealed that frequent volunteering at W1 exerts significant impacts on CRP (Appendix H). It is evidenced that status of participation alone is not sufficient to explain the variability in chronic inflammation. In KSHAP, the majority of respondents were active as volunteers (n=83), meeting attenders (n=173), and workers (n=435), but this group may be heterogeneous in terms of the frequency or intensity of involvement from sporadic to very frequent participation. Knowing the frequency of activity would enable researchers to examine the health benefits of productive activity involvement.

Though the study is novel in several important ways, the findings should be interpreted with caution due to study limitations. First, the Korean dataset is based in typical rural older adults sample, thus may not be representative of all Korean older adults. Since the majority of Korean older adults reside in rural areas, city or suburban residents may have a vastly different activity profile due to the differential access to activities and support systems. This calls for more nationally representative and comparative studies in order to evaluate the productive aging model across different cultures. Second, no precise timing of reported changes in productive activities are available. Though changes in the activities move beyond the static measures of cross-sectional data, it is not possible to assess when older adults' activity actually started and ended. Finally, multiple measures of chronic inflammation and immune function (IL-6, TNF-a, fibrinogen) are considered to be more beneficial than a single indicator (Herd et al., 2012). The current dataset has one type of inflammatory markers, but the future research should evaluate multiple indicators of biological systems.

Despite these study limitations, changes of productive activities over time predicted CRP, an important biological risk factor. This finding is another step towards advancing the research of health benefits of productive activity. In addition, the current project calls attention to a more nuanced understanding of adults partaking in multiple roles to varying degrees. Moreover, the results of the current study suggest the need for health interventions and research designed to promote and *maintain* productive activity with an explicit attention to potential gender differences.

Table 3-1. Descriptive Statistics for Study Variables, NSHAP and KSHAP

	NSHAP (n=1,124)		KSHAP (n=640)[a]		
	Range	Mean (SD)	Range	Mean (SD)	
Log CRP at W1	-3.47–2.14	.12 (1.03)	-3.91–2.14	-.12 (.89)	***
Log CRP at W2	-3.35–2.15	.53 (.95)			
Productive Activity at W1					
Volunteering	0–6	2.37 (2.10)	0, 1	.13	
Attending Meetings	0–6	2.90 (2.12)	0, 1	.27	
Caregiving	0–2	.20 (.56)			
Employment	0–2	.53 (.78)	0, 1	.68	
Productive Activity at W2					
Volunteering	0–6	2.33 (2.16)			
Attending Meetings	0–6	2.84 (2.19)			
Caregiving	0–2	.21 (.56)			
Employment	0–2	.29 (.60)			
Demographics					
Age	57–85	69.30 (7.85)	58–96	72.25 (7.87)	***
Female	0, 1	.52	0, 1	.60	***
Non-Hispanic White	0, 1	.77			
Black	0, 1	.17			
Other Race	0, 1	.06			
Married	0, 1	.62	0, 1	.74	***
Education	0–3	1.47 (1.07)	0–2	0.15 (0.45)	
Low Net Worth	0, 1	.22	0, 1	.15	***
Health Lifestyle Factors					
Tobacco Use	0, 1	.15	0, 1	.12	
Physical Activity	0–4	3.11 (1.36)			
Obesity	0, 1	.38	0, 1	.04	***
Depressive Symptoms	0–32	5.55 (5.19)	0–29	6.44 (4.69)	***
Chronic Conditions					
Emphysema	0, 1	.11			
Asthma	0, 1	.10	0, 1	.07	
Diabetes	0, 1	.19	0, 1	.19	
Lipid Medication	0, 1	.37	0, 1	.08	***

[a] Variable values reported for all the questions that are available for each survey.
Note: asterisks denote significant differences between KSHAP and NSHAP samples on comparable measures.
*p<.05, **p<.01, ***p<.001

Table 3-2. Ordinary Least Squares Regression Predicting Log CRP at W2, NSHAP (n=1,124)

	Volunteering		Attending Meetings		Caregiving		Employment	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Volunteering	0.00	.01						
Attending Meetings			-0.01	.01				
Caregiving					0.04	.05		
Employment							-0.02	.04
Age	-0.01*	.00	-0.01*	.00	-0.01*	.00	-0.01*	.00
Female	0.01	.06	0.01	.06	0.00	.05	0.00	.06
Black [a]	0.01	.08	0.01	.08	0.00	.08	0.00	.08
Other Race [a]	0.09	.10	0.09	.10	0.09	.10	0.09	.10
Married	-0.11	.06	-0.11	.06	-0.11	.06	-0.11	.06
Education	0.01	.03	0.01	.03	0.00	.03	0.00	.03
Low Net Worth	-0.07	.07	-0.08	.07	-0.07	.07	-0.07	.07
Tobacco Use	0.01	.08	0.00	.08	0.00	.08	0.00	.08
Physical Activity	0.01	.02	0.01	.02	0.01	.02	0.01	.02
Obesity	0.22***	.05	0.22***	.05	0.22***	.05	0.22***	.05
Depressive Symptoms	0.00	.01	0.00	.01	0.00	.01	0.00	.01
Emphysema	0.11	.08	0.11	.08	0.11	.08	0.11	.08
Asthma	0.12	.09	0.12	.09	0.12	.09	0.12	.09
Diabetes	-0.03	.07	-0.03	.07	-0.03	.07	-0.03	.07
Lipid Medication	-0.06	.05	-0.06	.05	-0.06	.05	-0.06	.05
Wave 1 CRP	0.23***	.01	0.23***	.01	0.24***	.01	0.23***	.01
Selection λ	0.37	.20	0.37	.20	0.38	.20	0.37	.20
Constant	0.64	.33	0.65	.33	0.66	.33	0.71	.35
Adjusted R^2	.2514		.2523		.2522		.2516	

[a] Non-Hispanic White serving as a reference group

* p<.05, ** p<.01, *** p<.001

Table 3-3. Changes in Productive Activity Predicting Log CRP at W2, NSHAP (N=1,124)

	Volunteering		Attending Meetings		Caregiving		Employment	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Increase Activity [a]	0.02	.09	0.01	.09	-0.04	.09	0.22	.12
Decrease Activity [a]	-0.06	.08	-0.09	.09	0.07	.09	-0.01	.07
Maintain Activity [a]	-0.05	.08	-0.18*	.08	0.03	.19	-0.03	.08
Age	-0.01*	.00	-0.01*	.00	-0.01*	.00	-0.01*	.00
Female	0.01	.05	0.01	.05	0.01	.05	-0.01	.06
Black	0.01	.08	0.01	.08	-0.01	.08	0.01	.08
Other Race	0.09	.10	0.08	.10	0.09	.10	0.09	.10
Married	-0.11	.06	-0.11	.06	-0.11	.06	-0.11*	.05
Education	0.01	.03	0.01	.03	-0.01	.03	0.01	.03
Low Net Worth	-0.07	.07	-0.08	.07	-0.07	.07	-0.07	.07
Tobacco Use	0.01	.08	0.01	.08	-0.01	.08	0.01	.08
Physical Activity	0.01	.02	0.02	.02	0.01	.02	0.01	.02
Obesity	0.22***	.06	0.22***	.05	0.22***	.05	0.23***	.05
Depressive Symptom	0.01	.01	0.01	.01	0.01	.01	0.01	.01
Emphysema	0.11	.08	0.11	.08	0.11	.08	0.10	.08
Asthma	0.12	.09	0.12	.09	0.12	.09	0.12	.09
Diabetes	-0.03	.07	-0.03	.07	-0.03	.07	-0.03	.07
Lipid Medication	-0.06	.05	-0.06	.05	-0.06	.05	-0.06	.05
Wave 1 CRP	0.23***	.01	0.23***	.01	0.23***	.01	0.23***	.01
Selection λ	0.38	.20	0.36	.20	0.38	.20	0.39	.20
Constant	0.68	.34	0.65	.34	0.65	.33	0.64	.35
Adjusted R^2	.2513		.2562		.2511		.2530	

[a] The reference group is no activity at W1 and W2.
* p<.05, ** p<.01, *** p<.001

Table 3-4. Ordinary Least Squares Regression Predicting Log CRP, KSHAP and NSHAP

	KSHAP in 2012 (n=640) W1 Log CRP (mg/L)		NSHAP in 2012 (n=1,790) W2 Log CRP (mg/L)	
	Coefficient	SE	Coefficient	SE
Volunteering Status	-1.18	.93	-.02	.02
Attending Meetings Status	.46	.70	-.02	.02
Employment Status	-.47	.69	-.04	.05
Age	.02	.05	-.01	.01
Female	-2.38**	.73	.07	.06
Black			.24*	.11
Other Race			.11	.13
Married	.55	.77	-.12	.07
Education	-.17	.35	-.02	.03
Low Net Worth	.78	.60	-.10	.09
Tobacco Use	2.39**	.98	.20*	.09
Obesity	.16	.62	.43***	.07
Depressive Symptoms	-.04	.07	.01	.01
Asthma	.72	1.12	.18	.10
Diabetes	-.61	.77	.01	.08
Lipid Medication	-.07	1.14	-.16*	.06
Constant	2.86	4.16	.44	.30
Adjusted R^2	.0465		.0700	

* p<.05, ** p<.01, *** p<.001

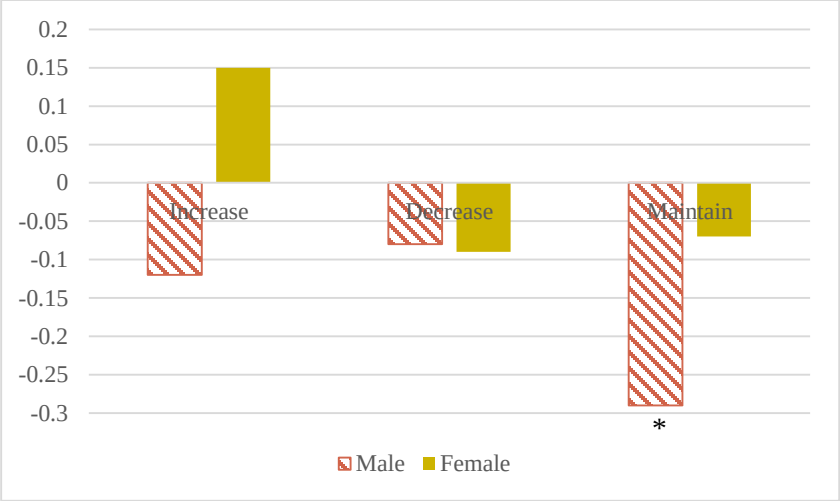

Figure 3-1. Changes in log CRP from Meeting Attendance in NSHAP, Stratified by Gender

Note: * denotes the significant differences at $p<.05$

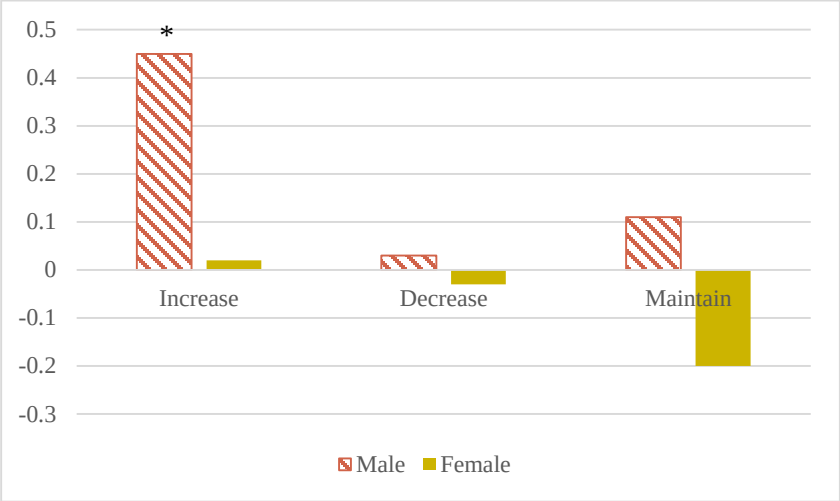

Figure 3-2. Changes in log CRP from Employment in NSHAP, Stratified by Gender

Note: * denotes the significant differences at p<.05

CHAPTER 4. PRODUCTIVE ACTIVITIES, SUBJECTIVE SLEEP QUALITY, AND LONGITUDINAL RISK OF INFLAMMATION: POTENTIAL PATHWAYS?

4.1 Abstract

Objective. Productive activities are widely extolled as salutary, affecting a range of physical and mental health outcome. Systemic inflammation (often measured with C-reactive protein) is considered a potential key mechanism linking these associations. However, the pathway through which productive activity reduces chronic inflammation is unclear, possibly due to lack of longitudinal data. Given the documented health benefits of older adults' productive activities, a critical next step is to identify how these effects are manifested.

Method. Using two waves from the National Social Life, Health, and Aging Project (NSHAP) of older adults 57 and older, the current study examined whether older adults participating in productive activities show better subjective sleep quality, which subsequently is associated with CRP (mediation hypothesis). The project also investigated whether the relationship between productive activity and CRP was contingent upon better sleep quality (moderation hypothesis).

Results. The results showed that the inverse relationship between volunteering and CRP was significantly stronger among those who reported adequate sleep (sleep duration of 6 hours or more on average). Further, frequent volunteers who also reported adequate amount of sleep reported the lowest levels of CRP at the subsequent wave. Sleep quality did not operate as a mediating pathway between any productive activity and CRP.

Discussion. The findings reveal productive activity protects against chronic inflammation and better sleep quality. Getting an adequate amount of sleep may be a potential mechanism of this association.

4.2 Introduction

Productive activities are widely extolled as salutary for older adults, affecting a range of physical and mental health outcomes such as enhanced psychological well-being (Matz-Costa et al., 2014), lower depressive symptoms, (Glass et al., 2006) and lower rate of all-cause mortality (Glass, Mendes de Leon, Marottoli, & Berkman, 1999). The findings provide strong support for the successful aging model pioneered by Rowe and Kahn (1997), who suggested that the significance of participating in productive activities for well-being is distinct from simple engagement in social relationships or a social network. Recently, studies indicated that the benefits of productive activity may extend above and beyond self-rated health or psychological well-being. For example, in cross-sectional data, productive activity and frequent volunteer activity in particular is related to lower chronic inflammation, an important biological risk factor in disease process (Kim & Ferraro, 2014).

Despite extensive research on productive activity and health, the pathway through which productive activity exerts its salutary effects is unclear, possibly due to lack of longitudinal data. Given the documented health benefits of older adults' participation in productive activities, a critical next step is to identify *why* these health effects manifest. Studying pathways or mechanisms also offers practical values as health practitioners and researchers develop interventions to promote older adults' activity that focus on particular behavioral, psychological, and biological outcomes leading to better health.

One of the underlying pathways studied extensively in the literature is sleep and inflammation. In both laboratory and large-scale epidemiological studies, systemic inflammation increases as a result of poor sleep quality or sleep deprivation (Cho et al., 2015; Irwin, Carrillo, & Olmstead, 2010). Indeed, a recent prospective study adds to this literature, showing that a one-hour reduction in sleep leads to 8.1% higher C-reactive protein and 4.5% higher interleukin-6 levels five years later (Ferrie et al., 2013). The findings yield significant clinical implications for

better sleep quality because even smaller fluctuations in chronic inflammation can be detrimental to cardiovascular disease (CVD) outcomes in older adults (Ridker et al., 2000).

At the same time, sleep and chronic inflammation are shaped by individuals' social environment, such as intimate relationships (Kiecolt-Glaser et al., 2010), social engagement, and leisure activities (Lin et al., 2012). Taking advantage of sleep quality and inflammation as modifiable health outcomes, the current project focuses on the relationships between productive activity and chronic inflammation while paying particular attention to sleep quality as a pathway. Two distinct pathways are hypothesized. The mediating pathway specifies that productive activities manifest both direct and indirect effects on chronic inflammation through better sleep quality. The moderating pathway stipulates that the link between productive activity and inflammation is contingent upon better sleep quality.

I specifically examine inflammation and sleep quality for at least two reasons. First, both sleep quality and inflammation show an age-graded change and have significant implications for disease outcomes in older adults. Individuals gradually enter into a pro-inflammatory state as they get older and become more vulnerable to a host of diseases (Crimmins & Vasunilashorn, 2011). Studying chronically elevated inflammation as a harbinger for age-related diseases such as CVD or cancer may enable an effective disease prevention. Similar to an age-related increase in inflammation, chronic sleep problems such as obstructive sleep apnea (OSA) show a relatively linear increase with age (Vgontzas, 2008). Poor sleep quality and sleep complaints also becomes more prevalent in later life and are associated with adverse health outcomes including chronic inflammation (Friedman, 2011; Suarez, 2008). In all, the prior studies show that both sleep quality and inflammation are germane health issues among older adults.

Second, both indicators are modifiable through enhancing social relations or active participation in various activities. Study of social integration and health is a cogent research topic in sociological literature. It has been found that older adults who are well-connected with others

in their community report better subjective sleep quality (not objective sleep quality) as well as lower risks for chronic inflammation (Benloucif et al., 2004; Ford, Loucks, & Berkman, 2006). Since productive activity proactively connects individuals to their community and brings other positive health outcomes, one can make a convincing argument that it is also beneficial for physiological health and sleep quality. However, I am unaware of any study that has examined links between productive activity, sleep quality, and chronic inflammation as interrelated pathways.

In this study, I propose two specific research questions. First, do older adults reporting frequent productive activity (measured by volunteering, meeting attendance, caregiving, and employment) show better sleep quality, which subsequently is associated with lower chronic inflammation (mediation hypothesis)? Second, is the relationship between productive activity and chronic inflammation contingent upon better sleep quality (moderation hypothesis)?

4.2.1 Productive Activity, Sleep Quality, and Chronic Inflammation

The current project is informed by three interrelated lines of inquiry. First, research establishes chronic inflammation as a potential predictor of cardiovascular disease (CVD) mortality (Crimmins & Vasunilashorn, 2011; Ridker et al., 2000). Heart disease is accountable for 1 in 4 deaths in the United States, affecting the majority of older adults. The most common risk factor for developing heart disease is atherosclerosis, and inflammatory proteins such as C-reactive protein (CRP) play a key role in arterial plaque formation, thereby greatly increasing the susceptibility to myocardial ischemia and infarction (Bennett et al., 2013; Vgontzas, 2008). In fact, CRP is an independent predictor of CVD even after adjusting for traditional risk factors such as total cholesterol level, BMI, and diabetes status. It has been also shown that chronic inflammation is related to cancer development (Bennett et al., 2013).

Second, converging evidence suggests that the inflammatogenic effects of sleep deprivation may be an important pathway linking social environment and health. Sleep is a quintessential restorative behavior through which one detoxifies substances accumulated when awake and restores energy levels for the next day. Thus, curtailed sleep and poor sleep quality have dramatic effects on physiological dysregulation. Laboratory studies show a change in inflammatory makers in response to sleep deprivation. Short-term sleep deprivation (i.e., 4 hours for one night) appears to exert a dynamic yet short-lived effect on inflammatory markers. In an innovative study on deprived sleep and leukocyte gene expression for inflammatory messenger RNA, one night of sleep loss induced a threefold increase in transcription of IL-6, but the effect did not last in the afternoon (Irwin, Wang, Campomayor, Collado-Hidalgo, & Cole, 2006). In contrast, a relatively long-lasting sleep loss leaves a noticeable mark on inflammation. Meier-Ewert et al. (2004) compared 8.2 versus 4.2 hours of sleep for 10 consecutive days in healthy young men and women and found that those who were sleep-deprived showed more than a five-fold increase in CRP from 0.05 before the experiment to 0.27 afterwards. Those who had normal sleep patterns exhibited no changes in CRP. Another study showed that 4 hours of sleep (50% decrease) for 5 consecutive days lead to 150% increase in CRP that continues even during the recovery period (van Leeuwen et al., 2009). There is evidence of gender differences, with women exhibiting extended elevation in IL-6 or tumor necrosis factor-α (TNF-α) in response to sleep loss (Irwin et al., 2010). Taken together, the findings indicate sleep as a critical health behavior that is linked to several health outcomes, with inflammation being an important one. Although the literature shows a sizeable effect of sleep loss on inflammation, these effects of sleep are almost exclusively studied in healthy young adults (mean ages in the mid-20s) without any chronic conditions or sleep complaints, warranting more studies in older adults with some preexisting conditions.

Sleep quality is a particularly germane issue since there is an age-related increase in sleep complaints, with more than half of adults over 65 reporting at least one (Benloucif et al., 2004). Strike and Steptoe (2003) provides a systematic review that demonstrates an intricate link between sleep patterns inflammation in the context of cardiovascular disease, showing that almost 1 in 4 myocardial infarction occurs within three hours of waking with changes in sleep activities and dysregulated diurnal rhythm in inflammatory cytokines (e.g., IL-6 and CRP). In community-dwelling older adults, both subjective and objective measures of sleep quality were negatively associated with inflammatory proteins as measured by IL-6, E-selectin, and TNF-α (Friedman, 2011; Prather et al., 2009). Friedman (2011) found the relationship is more pronounced among men. The extant literature in community-dwelling adults indicates that impaired sleep, whether measured objectively or subjectively, predicts higher circulating levels of inflammatory proteins in young and older adults.

The final line of inquiry focuses on how social relationships and social engagement in general affect sleep quality and inflammation. Sleep research has long been deemed biological in origin, but a burgeoning literature situates sleep within the individual and social contexts such as age, gender, social relationships, and work. Sleep, in this respect, is the new avenue of studying a range of research topics such as social environment, health, and aging. Studies demonstrate that social engagement improves older adults' subjective sleep quality in both experimental and population-based studies (Benloucif et al., 2004; Friedman, 2011). A study using data from the Midlife in the United States (MIDUS) explicates the moderating effects of sleep quality on the link between positive relationships (derived from Ryff's psychological well-being scale) and inflammation (Friedman, 2011). Results show that better sleep quality compensates for the lack of positive social relationships on inflammation (i.e., IL-6 and E-selectin). This link was also stronger for middle-aged and older men compared to women. It may be that the positive effects of productive activity are contingent upon the extent to which older adults report better quality of

sleep. The author concludes that focusing on only one of these outcomes misses the important evidence regarding the factors that may be protective against chronic inflammation. Another possibility is that sleep quality mediates the link between productive activity and CRP. Several review articles suggest that neuroendocrine and immune functions follow circadian rhythm dictated by sleep-wake cycles (Uchino, 2006). Negative and positive social experiences (e.g., social support, psychological stressors, social integration) may (dys)regulate the sleep cycle, which subsequently influences inflammatory cytokine productions.

In sum, the three separate yet interrelated strands of research lead to tenable questions whether sleep quality moderates or mediates the association between productive activity and chronic inflammation. Though inflammation and sleep study were considered as separate health outcomes in studies, considering both as interrelated health outcomes is essential for understanding how productive activities affects health in later life.

4.3 Method

The project used the first (W1) and second (W2) waves of data from the National Social Life, Health, and Aging Project (NSHAP), an ongoing nationally representative longitudinal study of 3,005 older adults residing in the United States. NSHAP W1 was collected in 2005-2006 and comprised of older adults aged 58 and older. The initial response rate was 75%. During the interview, a random 83% sample (n=2,494) was selected to undergo blood spot collection, of which 2,120 respondents agreed to provide sample (85% response rate). Williams & McDade (2009) showed that those who did not provide blood samples were not different from those who agreed by age, gender, race, income, education, marital status, self-rated health, and number of doctor visits in the past year. Additional 181 cases were discarded due to reasons such as insufficient volume of blood or equipment malfunctions. As is standard in the literature, 209

cases with very high levels of CRP (>8.6 mg/L), indicative of inflammatory response to acute conditions such as flu or injury, were excluded (Herd et al., 2012).

By 2010-2011, when W2 data were collected, 220 respondents had died; 88 were in very poor health or in a care facility; and an additional 94 respondents were not reinterviewed due to various reasons including refusal or lack of contact information. Of 1,328 eligible interviewees, 167 respondents had very high levels of CRP and were excluded from the analyses. Finally, since only 37 cases had missing data on control variables, they were omitted from the sample. The final analytic sample size is 1,124. A detailed sample flow chart is presented in Appendix J

4.3.1 Measures

Dependent Variables

CRP Concentration. In the NSHAP, during the face-to-face interview at both waves, a blood sample was collected via capillary finger stick and disposable lancet; up to five drops of blood were applied to filter paper for transport and storage. Blood-spot assays were completed at the Laboratory for Human Biology Research at Northwestern University (Williams & McDade, 2009). Given the highly positively skewed distribution of CRP (few individuals have higher levels of CRP), the values were natural log transformed.

Subjective Sleep Quality. Subjective sleep quality is based on four questions that were asked of all respondents (1 item at W1, 3 items at W2). Sleep duration at W1 was assessed with a single item "how many hours do you usually sleep at night?" with the response options in whole hours. At W2, instead of reporting the hours of sleep in general, participants responded with clock time on the questions "what time do you usually go to bed and start trying to fall asleep?" and "what time do you usually wake up?" The questions were asked separately for weekdays (work days) and weekends (days off). Average sleep duration was calculated from bedtime and wake time questions for weeknights and weekend (weighted 5/7 and 2/7). Tapping into both ends

of abnormal sleep duration (too little or too much sleep), three categories were created for *insufficient sleep* (<6), *adequate sleep* (6 to <9), and *high sleep* (≥ 9), with adequate sleep serving as a reference category, consistent with the literature (Dowd, Goldman, & Weinstein, 2011). A sleep quality item was included in the scale for depressive symptoms, in which participants were asked if their "sleep was restless" with four levels of response endorsement from rarely or none of the time (0) to most of the time (3) with higher number indicating more *restless sleep*. Overall sleep satisfaction was evaluated with the question "How often do you feel really rested when you wake up in the morning?" with the response categories ranging from never (0) to most of the time (3) with higher number indicating more *rested sleep*. Detailed information on sleep quality data collection and measures are available in Lauderdale et al. (2014).

Independent Variables: *Productive Activity*. Four productive activities were measured: volunteering, meeting attendance, employment, and caregiving. In the NSHAP, each of the measures is available in the analytic sample at both W1 and W2. The frequency of activity was measured by items asking respondents how often they participate in each activity.

For *volunteering*, respondents answered how often they volunteered for religious, charitable, political, health-related, and other organizations in the past 12 months. Responses ranged from never (coded 0) to several times a week (6). Using the same response categories for volunteering, they were also asked how often they attend organized meetings (*attending meetings*). For *employment*, respondents answered the number of hours they typically work during one week. I defined those who work 40 hours or more a week as full-time workers, resulting in three categories for no work (0), part-time (1), and full-time (2) employment. Additional analyses examined alternative threshold for full-time employment (e.g., 35 hours) but the conclusions were unchanged. For *caregiving*, participants were asked whether they are currently assisting an adult who needs help with day-to-day activities because of age or disability.

If answered yes, they were then asked how many days per week they typically spend caring for this person. The original response ranged from 0 to 7 days. However, because the majority of caregivers provided full-time care (7 days a week), I created three categories for no care (0), part-time (1), and full-time caregiving (2).

Additional Covariates. In addition to the variables of central interests, several covariates were considered because of their documented links with sleep quality and chronic inflammation (Herd et al., 2012; Kim & Ferraro, 2014). In the NSHAP, all covariates were measured at W1. *Age* is coded in years, and sex is dichotomized with 1 indicating *female*. Race was divided into a series of binary variables (*White*, *Black*, and *other race*) with non-Hispanic White serving as a reference category. Other race consisted of American Indian or Alaskan Native, Asian or Pacific Islander, and those who identified themselves as other race. Marital status is a binary variable with 1 indicating married or cohabiting with a partner. In order to measure socioeconomic status, four categories of *education* (less than high school, high school graduate, some college, and bachelor's degree or more) and *low net worth* were included in the analysis. For net worth, respondents were asked to estimate their net worth including all of their investments, properties, and other financial assets minus debt. A binary variable was created distinguishing respondents in the lowest 20% of the household net worth from those in the top 80%.

For health-related life style factors considered to predict CRP, I used self-reported information. *Tobacco use* was defined by current consumption of cigarettes, pipes, cigars, or chewing tobacco. *Physical activity* was measured with an item probing respondents' frequency of physical activities such as walking, dancing, or exercise (0-never, to 4-three or more times per week). Binary for *obesity* was defined by calculating body mass index with interviewer-measured height and weight ($> 30 kg/m^2$). *Depressive symptoms* were based on the 10-item Center for Epidemiologic Studies Depression Scale (CES-D) without the sleep question (Chronbach's $\alpha = .79$). Finally, the analysis adjusts for clinically relevant chronic health

conditions in order to alleviate concerns for reverse causality in the productive activity-CRP relationship. Respondents were identified as having a condition if they were ever diagnosed by a physician for *emphysema, asthma, and diabetes*. Further, given a documented inverse relationship between lipid-lowering treatment and CRP (Ridker et al., 2000), a binary variable for *lipid medication* use was included in the analyses.

Additional analyses included other covariates (i.e., income, controlled and uncontrolled hypertension, former smoking, underweight, overweight, religious service attendance, network size, total volume of contact, and self-reported physical/mental health) and alternative coding of variables (i.e., continuous measure of net worth). These were omitted from the final analyses, however, because they were not significant in any of the multivariate specifications.

4.3.2 Analyses

The analyses used generalized structural equation models (GSEM) for the mediation analysis and ordinary least squares (OLS) for the moderation analysis. SEM is developed to test an unobserved construct (latent variable) through multiple observed items (Skrondal & Rabe-Hesketh, 2004). GSEM offers several advantages for testing the mediation in the current project because it allows for the estimation of several equations (or pathways) simultaneously, so that the association between productive activity and sleep quality, comprised of multiple ordinal items, and the link between sleep quality and CRP are evaluated in the same model as opposed to the traditional multi-step models (Skrondal & Rabe-Hesketh, 2004). GSEM also allows the distribution of outcome variables to be dichotomous, ordinal (e.g., sleep quality), or log transformed (e.g., CRP).

In order to test the moderation effects, the analyses used ordinary least squares (OLS) regression to model the changes in CRP (by regressing W2 CRP on W1 CRP) as well as the W1 predictors as lagged predictors with and without the multiplicative term. The additive model

(model with variables specified as independent predictors) and interaction model were compared using the log likelihood test. If the results for the log likelihood ratio test are statically significant ($p<.05$), it indicates that the model fit with an interaction term is better than the model without an interaction term. Each interaction term was added to a separate model as opposed to being in the same model altogether.

In the NSHAP, re-interview rates were high in the follow-up study (i.e., 87.8% of the NSHAP W1 survivors re-interviewed) but sample attrition may nonetheless produce biased parameter estimates in longitudinal analyses. Since the majority of attrition was due to death, Heckman's (1979) selection bias models were employed to adjust for the differential selectivity due to mortality. I first estimated a probit model to distinguish respondents who participated at the follow-up interview from those who died. Predictors of mortality in the probit model included age, female, and tobacco use along with several variables that were *not* in the substantive equation predicting CRP (i.e., difficulty in activities of daily living (ADL), underweight (BMI $\leq$ 18.5), and self-rated health). The selection instrument (λ) based on the inverse Mills ratio was subsequently estimated and included in the substantive regression models.

4.4 Result

Table 4-1 shows the descriptive statistics for study variables in the NSHAP. At W1, the average log CRP level was 0.12 (corresponding raw CRP value 1.82). Respondents reported good sleep quality in general, with 83% of them reporting an adequate amount of sleep (6 to 9 hours). Twelve percent reported less than 6 hours of sleep on average and 5% reported 9 hours or more. They rarely reported restless sleep (mean=0.87, SD=0.98) and often reported that they felt rested in the morning (mean=2.48, SD=0.79). The mean volunteering and meeting attendance were 2.37 and 2.90 respectively, between several times a year and once a month. About 8% of

the entire sample was providing full-time care while 4% were part-time caregivers. Seventeen percent of the respondents were full-time workers, and 18% were employed part-time.

At W2, the average inflammation level somewhat increased at 0.53 (raw CRP=2.46). In terms of sleep quality, 4% of the sample reported insufficient sleep (<6 hours) and 30% reported long duration of sleep (9 hours or more). Sleep quality shows no drastic changes between waves (mean for restless sleep 0.83 (SD=0.99) and the mean for restful sleep 2.58 (SD=0.72). The NSHAP respondents were still active in volunteering (mean=2.33, SD=2.16) and meeting attendance (mean=2.84, SD=2.19). About 6% of W2 respondents were part-time caregivers and 8% were full-time caregivers. Not surprisingly, employment shows changes over time with 14% part-time workers and 8% full-time workers in the sample.

<Table 4-1 about here>

4.4.1 Testing the Moderation Effect of Sleep Quality

Table 4-2 shows the results from ordinary least squares regression predicting W2 CRP. Model 1 includes volunteering, meeting attendance, caregiving, and employment at W1 as well as W1 CRP predicting W2 CRP. The results from Model 1 show that there is no main effect of any type of productive activity on W2 CRP when adjusting for all the covariates, W1 CRP, and non-random selection effects. Obesity and W1 CRP were significant predictors of W2 CRP. In the subsequent models, I tested combinations of multiplicative terms in order to examine the moderation effects of sleep quality. The interaction terms between each type of productive activity and each measure of sleep quality were created and entered into separate models (e.g., volunteering x insufficient sleep, volunteering x restful sleep, meeting attendance x insufficient sleep). The findings reveal a significant interaction effect between volunteer activity and insufficient sleep on W2 CRP ($b=0.03$, $p<.05$, Model 2). The log likelihood test shows that the

model fit with multiplicative term is significantly better than the model without it (F=2.09, p=0.02). In addition, Model 2 also explains 3% more of the total variance in W2 CRP (r^2=.30).

Other combinations of productive activities and sleep quality measures were not significant. The interaction terms tested in separate models include meeting attendance x insufficient sleep (b=0.03, p=0.49), caregiving x insufficient sleep (b=0.21, p=0.13), employment x insufficient sleep (b=-0.02, p=0.86), volunteering x restless sleep (b=-0.01, p=0.53), meeting attendance x restless sleep (b=0.01, p=0.32), caregiving x restless sleep (b=0.07, p=0.19), employment x restless sleep (b=0.03, p=0.54), volunteering x rested sleep (b=0.01, p=0.95), meeting attendance x rested sleep (b=-0.01, p=0.63), caregiving x rested sleep (b=-0.06, p=0.35), and employment x rested sleep (b=-0.01, p=0.89).

<Table 4-2 about here>

In order to aid the interpretation of the interaction term between volunteering and insufficient sleep, the results from the second column in Model 2 were graphically depicted in Figure 4-1. It clearly demonstrates that those who report sleep duration of less than 6 hours on average essentially have a flat line across the frequency of volunteering at W1 (horizontal axis). In other words, there are no substantial benefits from volunteer activity if one reports insufficient sleep. In contrast, older adults who reported sufficient sleep had a negative and linear line along the categories of volunteering frequency. Frequent volunteers who also report sufficient sleep exhibited the lowest level of CRP at W2 compared to less active volunteers or insufficient sleepers. It is also notable that sleep quality buffers the lack of volunteering in older adults, in that among inactive volunteers, sufficient sleepers were showing lower CRP levels than insufficient sleepers.

<Figure 4-1 about here>

4.4.2 Testing the Mediation Effect of Sleep Quality

Finally, the analyses tested for the mediation effects as hypothesized, even though there was minimal direct effect of productive activities on CRP. Sleep quality as a latent construct consisted of insufficient sleep, frequency of restless sleep, and frequency of restful sleep. The frequency of restful sleep was reverse coded so that higher numbers indicate less restful sleep. The results show that sleep quality does not act as a mediating pathway linking productive activities and chronic inflammation (SEM results shown in Appendix K).

4.5 Discussion

Using nationally representative sample of older adults in the United States, the current project examined potential mechanisms through which productive activity exerts protective effects against chronic inflammation, privileging sleep quality as a pathway. The results revealed that frequent volunteer activity is protective against chronic inflammation only to the extent to which older adults report sufficient sleep, even after controlling for demographics, health life style factors, chronic conditions, and W1 CRP. It is notable that volunteering by itself did not have a significant longitudinal effect on W2 CRP. Though cross-sectional studies show a direct association between volunteering and inflammation (Kim & Ferraro, 2014), the current study extends the previous findings and provides evidence that the anti-inflammatory effects of volunteer activity at W1 are contingent upon older adults' report of adequate sleep in longitudinal data. Further, it signifies the importance to consider multiple related health outcomes simultaneously rather than separately.

Interestingly, multiplicative terms between volunteering and other sleep measures were not significant in the model. It may be that sleep deprivation is the key contributor to the inflammatogenic process rather than feeling rested or restless after sleep. One study demonstrates that habitually low sleep duration is associated with various adverse health outcomes including

heightened inflammation, hypertension, and coronary heart disease, (Troxel, 2010). Other studies explored the proinflammatory effects of more serious or pathological sleep outcomes such as insomnia complaints (Cho et al., 2015) or obstructive sleep apnea (Vgontzas, 2008), indicating that moderate sleep issues (e.g., not feeling rested in the morning) might not be potent enough to impact the fluctuation in chronic inflammation in prospective data. Therefore, a key to developing successful interventions is to target insufficient sleep as a health outcome while paying attention to those who do not actively participate in productive activities as the most vulnerable to developing chronic inflammation.

Sleep quality did not mediate the relationship between productive activities and inflammation in older adults in the present analyses. It is not surprising, given that there was lack of direct effect of productive activity on CRP. It may be that sufficient sleep compensates for the lack of productive activity rather than operating as an intermediate pathway. A study on positive social relations and inflammation in older women found that sleep efficiency (sleep duration as a function of total time in bed) and positive social relations both had independent effects on IL-6 when included in the same model, suggesting that sleep quality did not mediate the relationship (Friedman et al., 2005).

To date, there was no longitudinal study testing whether older adults' productive activity affects chronic inflammation, and how sleep quality might moderate or mediate this relationship. Productive activity is specified as lagged predictors and all statistical models include two measurements (W1 and W2) for chronic inflammation. At the bivariate level, W1 CRP and W2 CRP showed a strong correlation. Further, W1 CRP is the strongest and most consistent predictor of W2 CRP than any other variables included in the model. The findings suggest that models including single measurement for CRP in cross sectional data with predictor variables may overestimate the association between any given predictor and chronic inflammation. Therefore,

use of prospective panel data provides convincing argument on the health benefits of volunteering and sufficient sleep, as well as some information on the directionality.

The findings should be interpreted with caution due to following limitations. The assessment of sleep quality relied upon self-reports, and more objective measures of sleep quality are needed in order to further understand the role of sleep in inflammatogenic process. Some objective sleep quality measures include sleep fragmentation (percent of sleep spent waking and percent less than 5 minutes of immobile sleep), sleep architecture (percent of slow-wave sleep), or sleep efficiency (percent of actual sleep by time spent in bed). Actigraphy may also measure sleep duration more accurately than self-reports. Second, though I utilized longitudinal data and adjusted for W1 CRP, nonrandom selection effects, health life style factors, and chronic conditions that are associated with inflammation, there could be other health conditions that confound the relationship between productive activities, sleep, and inflammatory markers. A causal findings of sleep quality and chronic inflammation is consistent with randomized controlled trials (Meier-Ewert et al., 2004), but could not be definitely confirmed from findings in the current project.

In conclusion, the current study extends the findings from cross-sectional data and provides the moderating effects of sleep quality on the link between productive activity (and volunteer activity in particular) and inflammation, measured by CRP. Given the role of inflammation and sleep deprivation in the disease development process and its modifiability, the findings suggest that productive activity may be a potential avenue for individuals to stay healthy and active in later life.

Table 4-1. Descriptive Statistics for Study Variables, NSHAP Wave 1 and Wave 2 (n=1,124)

	Range	Mean (SD)
Log CRP at W1	-3.47–2.14	.12 (1.03)
Log CRP at W2	-3.35–2.15	.53 (.95)
Productive Activity at W1		
Volunteering	0–6	2.37 (2.10)
Attending Meetings	0–6	2.90 (2.12)
Caregiving	0–2	.20 (.56)
Employment	0–2	.53 (.78)
Productive Activity at W2		
Volunteering	0–6	2.33 (2.16)
Attending Meetings	0–6	2.84 (2.19)
Caregiving	0–2	.21 (.56)
Employment	0–2	.29 (.60)
Sleep Quality at W1		
Insufficient Sleep (<6 hours)	0, 1	.12
High Sleep (≥ 9 hours)	0, 1	.05
Restless Sleep	0–3	.87 (.98)
Restful Sleep	0–3	2.48 (.79)
Sleep Quality at W2		
Insufficient Sleep (<6 hours)	0, 1	.04
High Sleep (≥ 9 hours)	0, 1	.30
Restless Sleep	0–3	.83 (.99)
Restful Sleep	0–3	2.58 (.72)
Demographics		
Age	57–85	69.30 (7.85)
Female	0, 1	.52
Non-Hispanic White	0, 1	.77
Black	0, 1	.17
Other Race	0, 1	.06
Married	0, 1	.62
Education	0–3	1.47 (1.07)
Low Net Worth	0, 1	.22
Health Lifestyle Factors		
Tobacco Use	0, 1	.15
Physical Activity	0–4	3.11 (1.36)
Obesity	0, 1	.38
Depressive Symptoms	0–24	4.10 (4.39)
Chronic Conditions		
Emphysema	0, 1	.11
Asthma	0, 1	.10
Diabetes	0, 1	.19
Lipid Medication	0, 1	.37

Table 4-2. Ordinary Least Squares Regression Predicting CRP in NSHAP (n=1,124)

	Model 1		Model 2	
	Coefficient	SE	Coefficient	SE
Volunteering	0.01	.02	-0.02	.02
Attending Meetings	-0.02	.02	-0.02	.02
Caregiving	0.02	.06	0.00	.04
Employment	-0.01	.04	0.02	.06
Volunteer*Insufficient Sleep			0.03*	.01
Insufficient [a]	-0.06	.10	-0.13	.13
High Sleep [a]	0.02	.02	0.02	.02
Restless Sleep	0.02	.04	0.02	.04
Restful Sleep	-0.07	.04	-0.07	.04
Age	-0.00	.01	0.00	.01
Female	0.02	.07	0.01	.07
Black [b]	0.17	.11	0.16	.11
Other Race [b]	0.10	.14	0.11	.14
Married	-0.12	.07	-0.13	.07
Education	-0.01	.03	0.00	.03
Low Net Worth	-0.02	.09	0.01	.09
Tobacco Use	-0.00	.09	0.02	.09
Physical Activity	0.05	.03	0.06*	.03
Obesity	0.23***	.07	0.25***	.07
Depressive Symptoms	0.01	.01	0.01	.01
Emphysema	0.12	.10	0.12	.10
Asthma	0.12	.10	0.12	.10
Diabetes	-0.04	.08	-0.04	.08
Lipid Medication	-0.05	.06	-0.05	.06
Wave 1 CRP	0.24***	.02	0.23***	.02
Selection λ	0.09	.25	0.11	.25
Constant	0.13	.43	.04	.43
Adjusted R^2	.27		.30	

[a] Adequate sleep (≥ 6 hours to < 9 hours of sleep) serving as a reference group
[b] Non-Hispanic White serving as a reference group
*p<.05, **p<.01, ***p<.001

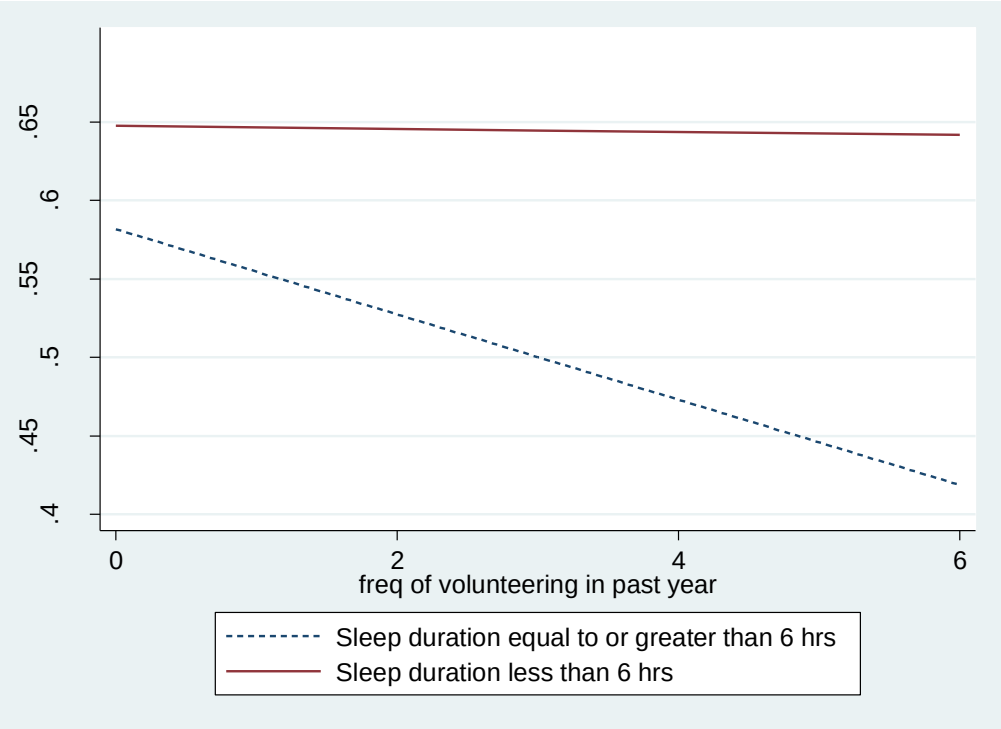

Figure 4-1. Volunteering and C-Reactive Protein, Stratified by Sleep Duration
Note: Results adjust for all covariates, nonrandom selection lambda, and W1 CRP.

CHAPTER 5. DISSERTATION DISCUSSION AND CONCLUSIONS

The purpose of this chapter is to incorporate and synthesize the findings across three chapters, address important contributions of this dissertation as a whole to the knowledge of productive aging, and finally, acknowledge some limitations of the study.

One key assumption that underlies the current dissertation is that most older adults participate in productive activities. Indeed, the findings would not be very meaningful if only few older individuals volunteer or attend meetings. The popular portrayals of older adults have been feeble, inactive, and debilitated. In Jonathan Swift's novel, *Gulliver's Travels,* the immortal yet eternally decaying and disengaged Struldbrugs were depicted as the portrait of older age. Unfortunately, scholars also have contributed to the view on older adults' lack of role. Cumming and Henry (1961) argued that older adults withdraw themselves from society in preparation of their own death, and such mutual disengagement of individuals from the society and society from older individuals is, in fact, optimal.

However, an extensive body of literature on productive aging refuted this view by demonstrating that older adults are making an active contribution to society. In fact, data in Chapter 2 corroborate the trend that 63% of American older adults volunteered and 69% regularly attended organized meetings in 2005. More notably, the percentages were stable at 62% and 70% for volunteering and meeting attendance in 2010, respectively. It is remarkable that older adults with the mean age of 69.3 (and 74.5 in 2010) still identified themselves as volunteers, meeting

attenders, employees, and caregivers. Such data provide strong grounds and significance for studying predictors and consequences of productive activities.

Another important idea is that participation in productive activities, like any other activities, waxes and wanes over time. Studies found a great amount of variability in these activities in prospective data of older adults (Baker et al., 2005; Hinterlong, 2008). Hinterlong (2008) examined data from the American's Changing Lives study among adults aged 60 and older and found that in 1989, older Americans spent an average of 589 hours in productive activities with a standard deviation of 684 hours. In 1994, mean hours decreased to 280 hours with a standard deviation of 534. Findings from this project are consistent with prior studies, showing a decrease in means and a growth in variability between the waves. Thus, the analytic strategy that focuses solely on the status or static measures of participation may grossly underestimate the full extent of productive aging among older adults.

Taking into consideration these assumptions, what are the major contributions of this dissertation to the larger literature on productive aging? Informed by Sherraden and colleagues' (2001) model of productive aging, the project tested the social antecedents and health outcomes of productive activity. Chapter 2, 3, and 4 examined different segments of the productive aging model.

The first overall conclusion is that the role of multiple forms of capital on productive activities varies for the type of participation. The productive aging model provides a good starting point, that demographic variables (e.g., age, gender, and education) and individual capacities (e.g., health, cognitive ability, and time available) affect productive activities. Based on this model, some studies focused on the role of health or education in predicting productive activity in later life (Bertrand et al., 2012). However, Chapter 2 revealed that human, social, and cultural capital exerts differential effects on multiple forms of productive activity over time. Consistent with the

productive aging model, education was a strong predictor of all four types of productive activity in cross-sectional and longitudinal analyses.

Literature shows that education affects a breadth of outcomes in older adults including, but not limited to, daily health practices, social activities, and cognitive functioning (Gallant & Dorn, 2001; McLaughlin, Jette, & Connell, 2012). Given these findings, one can expect that education may exert the effects on productive activity through multiple mechanisms. It could be that educated older adults are embedded within a social network of other productive individuals, internalize the values of undertaking meaningful roles, have cumulative experiences and knowledge on various types of activity, or simply are exposed to more opportunities to become productive. Perhaps unsurprisingly, being asked to participate in productive activities increase the likelihood of participation (Morrow-Howell et al., 2001). If opportunities or access to productive activity are unequally distributed along the level of education, policymakers and practitioners need to develop community interventions that reach a broad spectrum of older adults with or without high levels of educational attainment. The findings on education also call for research that employs a life course perspective on later life outcomes. The majority of older adults have completed schooling in their 20s and 30s, yet education continues to influence various life domains into advanced ages including participation as well as the maintenance in productive activity. Older adults' activity and well-being should be considered as a continuum of previous trajectories rather than a status or stage.

Notably, functional limitation was not a significant predictor of the maintenance of productive activity net of demographics, health life styles, and chronic conditions. The supplementary analyses in Chapter 2 also revealed no significant effects of health on productive activities. Though health is an important resource for older adults that promotes various activities (e.g., Bertrand et al., 2012), the findings from Chapter 2 show that health may not hinder the maintenance of productive activities. This argument is consistent with other studies showing

differential effects of functional ability on volunteer activity among various age cohorts (Li & Ferraro, 2006; Tang, 2006). For middle-aged and young-old adults (55-69), functional ability positively predicted voluntary activity and frequency. However, there was no such evidence for older adults (70 and older). It may be that many older adults consider productive activities an important aspect of their identity and strive to continue their participation in any given activity in the face of some health problems. Further, health problem may operate as a compensatory mechanism (Li & Ferraro, 2006), not as a hindrance, particularly given the significance of finding a meaning and purpose in life among older adults compared to their younger counterparts (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000). Indeed, chronic conditions or health issues may prompt a perspective that there is a limited time in the future for older adults, who then seek for more emotionally gratifying experiences as opposed to future rewards.

Another important finding is that religious service attendance (measure of cultural capital) was a consistent predictor of volunteering and meeting attendance. Research establishes two possible pathways through which religion affects voluntary activities: religious obligation and religious network of opportunity. From religious perspectives in Christianity, Judaism, and Buddhism, neighborly love is a privilege and an obligation at the same time, something the pious individual has to abide by in obedience to God. In the Bible, the iconic parable of the good Samaritan in Luke 10: 29-37 captures the essence of neighborly love discussed above. In addition to the religious values in helping others and giving back to the community, the sheer frequency of attending religious services exposes older adults to various opportunities for benevolent activities (Lim & MacGregor, 2012). Simply put, those who go to church are more frequently asked to volunteer or attend meetings than non-churchgoers. Further, the significance of religion becomes greater in later life according to the statistics from Pew Research Center (2008). The supplementary analyses in Chapter 4 and 5 revealed no direct effects of religious service attendance on chronic inflammation, potentially meaning that older adults are provided

with opportunities to participate in various benevolent activities through religious organizations, and subsequently reap health benefits from such activities. Thus, studying volunteer activity and meeting attendance without taking into account religious participation may overestimate the effects of other predictors.

The longitudinal findings further compliment the traditional productive aging model by showing that same type of social antecedents or resources operates in different ways over time. Many studies focus on one activity using cross-sectional data, which loses a tremendous amount of heterogeneity within the group in terms of level of involvement, changes over time, and simultaneous participation in other productive activities. The findings from Chapter 2 showed that W1 participation was a significant predictor of W2 frequency for volunteering and meeting attendance. Further, functional limitations were not associated with these two activities in longitudinal analyses adjusting for W1 participation. That is, volunteers continued to volunteer and meeting attenders continued to attend meetings over a 5-year period. These findings are telling, particularly given that the goals for finding purpose and meaning in life and engaging in meaningful interactions become more salient in later life (Carstensen et al., 2000). Invoking role theory, for older adults who experience general lack of structured roles and norms (e.g., as a working mother or a student), volunteering or meeting attendance as a social role may provide a salient role identity with norms and behavioral guidance that persist over time. This also has significant implications for organizations concerning the recruitment and retention of older adults. In all, Chapter 2 is an initial step forward in studying how resources affect the changes in multiple productive activities in order to capture the variability in older adults' activity profiles.

The second overarching conclusion is that there are multiple pathways involved in elucidating the link between productive activity and chronic inflammation. Chapters 3 and 4 contribute to the knowledge on whether and *why* productive activities protect against chronic inflammation. Chapter 3 showed that the link between frequent volunteer activity and CRP was

significant only in cross-sectional data. The association was no longer significant in longitudinal data. In fact, even in cross-sectional data in NSHAP and KSHAP, volunteer status alone was not predictive of CRP. Some studies examining mental health outcomes such as life satisfaction or depressive symptoms found that simply being a volunteer was associated with positive outcomes in and of itself (Morrow-Howell, Hinterlong, Rozario, & Tang, 2003; Van Willigen, 2000). However, a meta-analysis of 29 papers on volunteering and health demonstrated that volunteering role (without frequency of activity) is predictive of mental health, but not physical health (Jenkinson et al., 2013). It may be that physical and emotional experiences within a role help explain physical health outcomes including inflammation.

Not surprisingly, assuming a productive role is more than a simple status. There are multiple aspects of role experiences including the frequency of activity, intensity of involvement, and quality of activity. There are few studies on various dimensions of a role and health outcomes. Matz-Costa and colleagues (2014) found that high role engagement level in volunteering (measured by vigor, dedication, and absorption) was associated with better well-being, while medium role engagement was related to lower well-being compared to no engagement. Siegrist & Wahrendorf (2009) took a similar approach and discovered that those experiencing non-reciprocity (higher burden than rewards) reported lower psychological well-being compared to nonparticipants. It is implied that frequent activity within a given role shows a higher level of positive experiences in a role, particularly voluntary roles. However, a person's experience with a role she or he occupies may be positive and pleasant or negative and burdensome. Thus, future research should tap into the subject aspects of role experiences such as the rating of the role experiences, reward-burden balances, and quality of relations with role partners.

Marked gender differences in productive activity and inflammation are consistent with a number of prior studies (Adelmann, 1994; Friedman, 2011). Maintaining meeting attendance

activity between 2005 and 2010 was associated with a slower rate of increase in chronic inflammation, but the effect was larger for male than female respondents. Again, this is after adjusting for baseline CRP levels, nonrandom selection effects, and other covariates. According to role theory, roles become sources of power, resources, prestige, and emotional gratification (Sieber, 1974). Thus, the gender differences on productive roles and health may stem from differential quality of experiences associated with undertaking a given role. In general, quality of role as an active community participant may be greater for older men who subsequently derive more prestige, ego gratification, and health benefits from undertaking the role than do women (Simon, 1995). In addition, certain roles such as a working role also protect physical health through health behavior modification or maintenance for men. On the other hand, part-time employment at retirement age for older men may be more detrimental than for older women. Moving from full-time employment to part-time generally represents the preparation stages for retirement, but moving from retirement to part-time job may reflect financial necessity rather than deliberate plans.

The moderating effect of sleep quality on the association between volunteering and CRP in Chapter 4 is another intriguing finding. Frequent volunteer activity was associated with CRP only to the extent to which the respondents report an adequate amount of sleep. Volunteering is associated with lower CRP in cross-sectional data (Kim & Ferraro, 2014) but the longitudinal association was moderated by insufficient sleep. There are potential explanations why this is the case. Sleep deprivation is associated with heart rate variability, systolic/diastolic blood pressure, insulin resistance, inflammation, and regulation of catecholamine (Spiegel, Leproult, & Van Cauter, 1999). Such a wide array of biological correlates of sleep deprivation indicates that poor sleep quality reflects the lack of organism's restorative quality against pathogens or cellular damage. Thus, the protective effects of volunteer activity against chronic inflammation may

interact with individual capacity to regulate the physiological system achieved from adequate sleep.

To conclude, it is important to acknowledge some key limitations of the dissertation. It is noted regarding the lack of data on the exact timing, duration, and changes in each type of productive activity. Though the majority of older adults maintained the activity between the two waves, one cannot distinguish those who remained active for over 20 years from the individuals who happened to be active only during the study period. Another possibility is that some older adults discontinued the activity right before the study period, thus excluded from the 'maintainer' group. Knowing the exact timing of any given activity enables researchers to properly estimate the health benefits of one year (or one month) of activity.

Related to the issues on the timing and duration, more measures are needed that tap into the level of involvement or quality of role experiences within productive roles. This dissertation only includes crude measurements for frequency of participation as an initial step to measure the intensity of involvement. However, no information is available regarding how many hours a person actually spent on various activities, how many organizations he or she was involved in, how much he or she was supported from role partners or the organization, or how a person perceived the experiences within a role. A simple role occupancy may be beneficial to a certain extent but the level of involvement or quality of a role are better indicators of the actual experiences within a role when predicting various health outcomes.

Another shortcoming of the study was that the older adults included in the sample are relatively healthy and well-educated. Although the current project adjusted for demographics and chronic conditions, about quarter of all older adults in NSHAP were college graduates, and 33% had at least some college education. Thus, the findings from the current dissertation cannot be extrapolated to the low-income disadvantaged population. At the same time, psychosocial resources necessary for productive activity are not evenly distributed in less privileged

populations, and those who desire to be productive with resource deficit may resort to more private type of activities (e.g., helping neighbors for transportation or doing chores for family and relatives) that are equally important but may not be captured in large-scale surveys (Musick & Wilson, 2007). Thus, a wider range of opportunities for productive aging is required for a broader spectrum of older adults with varying capacity and resources in the current aging society.

Despite the study limitations, the current dissertation provides evidence for the productive aging model, while simultaneously supplementing the model with explicit attention to cultural differences in health benefits of productive activity, intermediate pathways linking productive activity and health, and long-term changes in productive activities. The patterns of resources that shape productive activities as well as the health benefits of such activities surfaced in a complex way, but the findings highlight the significance of studying both causes and effects of productive aging in various contexts.

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APPENDICES

Appendix A Definitions of Productive Activity

Conceptual definition: Though the scholars agree that older adults involved in productive activities are providing valued goods and services that are sometimes unnoticed, there appears to be lack of consensus on how to define productive activity. Table 1A describes various conceptual definitions of productive activity in the extant literature. Morgan (1986) suggested a simple definition in line with economic conceptualization of productivity; production of goods and services, which reduce demands on goods produced by others. Herzog and colleagues then offered a broader definition in 1989, that productive activity includes "any activity that produces goods and services, whether paid or not (p. s129)." Finally, Bass and colleagues (1993) defined productive activity as "any activity that produces goods and services, whether paid or not, or that can develop the capacity to produce goods and services (p. 6)." They excluded activities that are solely enriching to the actor who performs them, such as physical exercise, intellectual, and spiritual activities. A majority of empirical studies reviewed (4 out of 6 studies that offered a conceptual definition on productive activity) adopted Caro and colleagues' definition.

Operationalization: Adding to the conceptual disagreement of productive activity, studies using the same conceptual definition do not measure the concept the same way. Table 1B summarizes the studies in which various productive activities are measured. The most widely measured types of activity are volunteering and caregiving (5/5 citations using the same conceptual definition). Paid work is also a commonly measured productive activity (4/5 citations). Housework and informal help were less likely to be included in the measures (3/5, and 2/5 citations, respectively). All in all, the measurements are in line with the conceptual definitions; activities that are included in multiple conceptual definitions are measured more often as well (e.g., paid work and volunteering) and those in one or two definitions are measured less commonly in empirical works (e.g., housework).

One common theme in the literature is that productive activity is and should be measured with multiple items because older adults can be more or less active in multiple roles. A potential problem, however, is that different types of productive activity exhibit distinct patterns over time; volunteering, housework, informal help, and meeting attendance are maintained even in later life whereas employment and caregiving show decreasing trends over time. Thus, some authors use a person-centered approach using latent class analyses (LCA) or a variable-centered approach using exploratory factor analyses (EFA) in attempt to classify these types of productive activities and how they wax or wane over time. Finally, intensity or frequency of each activity is measured with total hours of involvement in all roles combined, hours dedicated in each activity, or categorical variables of activity frequency.

Table 1A. Conceptual Definitions of Productive Activity

Citation	Definition
Burr et al. (2007)	Adopted Bass & Caro (2001): "Any socially valued activity that produces goods and services, whether paid or not" Housework (home maintenance) is included as productive activity
Bass & Caro (2001)	Book chapter from Morrow-Howell's *Productive Aging: Concepts and Challenges* Adopted Bass & Caro (1996) and Bass et al. (1993): "Any activity by an older individuals that contributes to producing goods and services, or develops the capacity to produce them, whether or not the individual is paid for."
Bass & Caro (1995)	A chapter from Crown's *Handbook on Employment and the Elderly* "Activity that produces social valued goods and services, whether sold in a market or not, as well as any activities that develop the capacity to produce them."
Bass, Caro, & Chen (1993)	An intro chapter from Bass, Caro, & Chen's *Achieving a Productive Aging Society*

	"Any activity by older individuals that contributes to producing goods and services, or develops the capacity to produce them (whether or not the individual is paid for this activity)… in other words, the activity should be quantified as to some form of economic value." Housework is not included as productive activity under this definition
Herzog et al. (1989)	"Any activity that produces goods and services, whether paid or not"
Morgan (1986)	"Production of goods and services, which reduce demands on goods produced by others"

Table 1B. Agreement and Discrepancies in Operational Definitions of Productive Activity

	Volunteering	Paid Work	Caregiving	Informal Help	Housework
Burr et al. (2007)	x	x	x	x	x
Fernandez-Ballesteros et al. (2011)	x		x		x
Hinterlong (2008)	x	x	x	x	
Sugihara, Sugisawa, Shibata, & Harada (2008)	x	x	x		x

Appendix B Changes in Productive Activities across Waves

Volunteering

		Wave 1		
		No	Yes	
Wave 2	No	405 (71.3%)	249 (21.8%)	654
	Yes	163 (28.7%)	894 (78.2%)	1,057
		568	1,143	1,711

Meeting Attendance

		Wave 1		
		No	Yes	
Wave 2	No	312 (65.4%)	205 (16.7%)	517
	Yes	165 (34.6%)	1,021 (83.3%)	1,186
		477	1,226	1,703

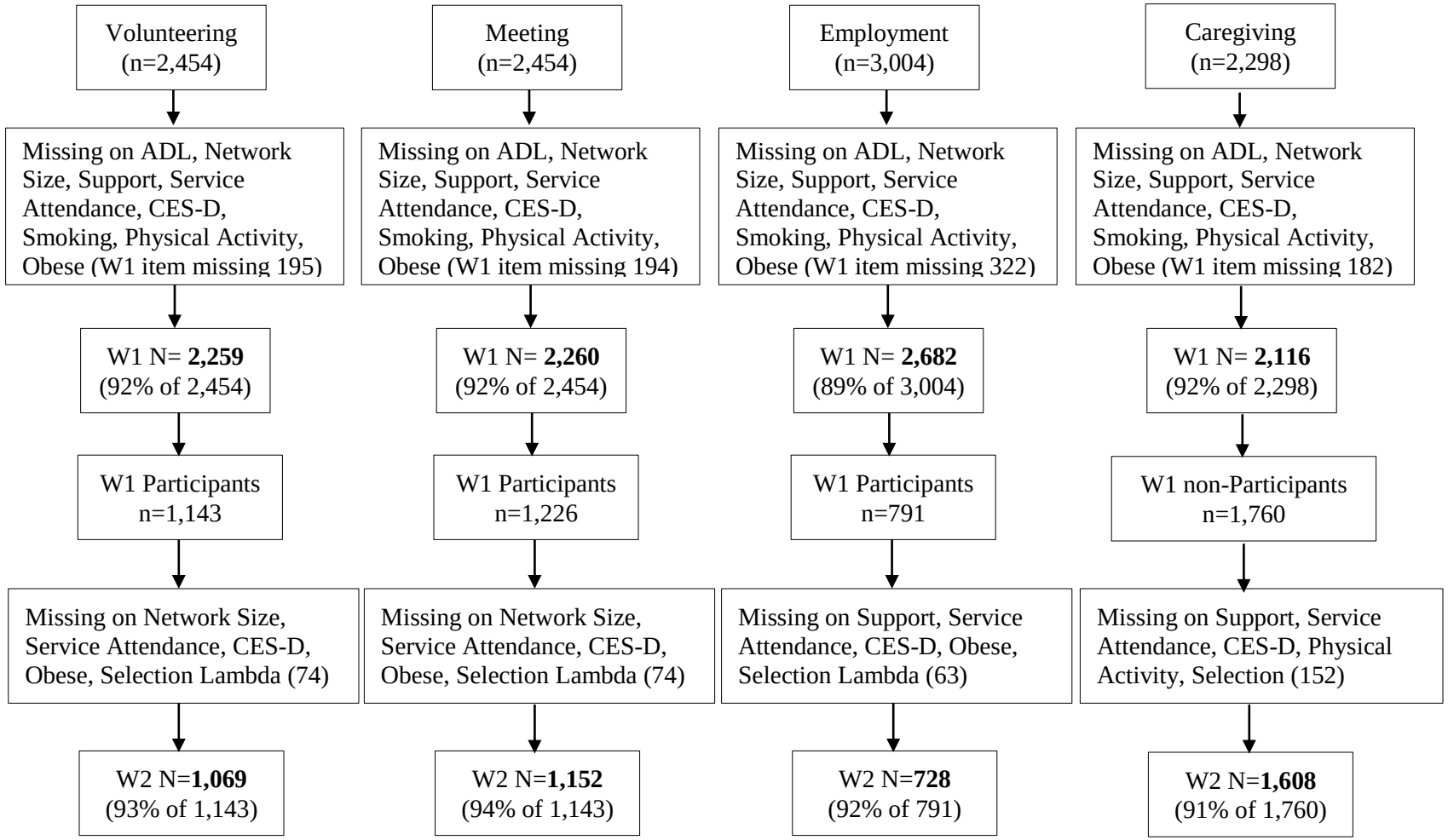
Employment

		Wave 1		
		No	Yes	
Wave 2	No	1,393 (95.2%)	395 (49.9%)	1,788
	Yes	71 (4.9%)	396 (50.1%)	467
		1,464	791	2,255

Caregiving

		Wave 1		
		No	Yes	
Wave 2	No	1,639 (93.1%)	200 (71.9%)	1,839
	Yes	121 (6.9%)	78 (28.1%)	199
		1,760	278	2,038

Appendix C Sample Flow Chart for Productive Activities, Wave 1 and Wave 2



Appendix D Multinomial Logistic Regression Predicting Changes in Productive Activities

	Volunteering (n=1,599)		Meeting Attendance (n=1,595)		Employment (n=1,723)	
	Decrease	Increase	Decrease	Increase	Decrease	Increase
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Human Capital						
Education	1.06 (0.93-1.20)	1.11 (0.97-1.27)	1.01 (0.89-1.15)	1.25 (1.10-1.43)**	1.54 (1.09-2.19)*	1.60 (0.92-2.77)
Functional Limitations	0.92 (0.83-1.02)	0.96 (0.86-1.08)	0.97 (0.87-1.07)	1.01 (0.92-1.12)	0.98 (0.68-1.43)	1.14 (0.57-2.29)
Social Capital						
Married	0.87 (0.66-1.15)	1.01 (0.75-1.36)	1.31 (0.99-1.73)	0.92 (0.69-1.22)	0.87 (0.42-1.80)	1.45 (0.44-4.78)
Network Size	1.08 (0.99-1.17)	1.07 (0.98-1.17)	1.02 (0.94-1.11)	0.97 (0.89-1.06)	0.94 (0.76-1.15)	1.02 (0.73-1.41)
Support	1.39 (1.01-1.92)*	1.09 (0.77-1.53)	0.95 (0.69-1.32)	1.08 (0.77-1.50)	1.10 (0.47-2.55)	1.63 (0.41-6.44)
Cultural Capital						
Religious Service Attendance	1.09 (1.02-1.16)**	1.11 (1.04-1.19)**	1.09 (1.02-1.16)*	1.11 (1.04-1.19)**	0.97 (0.84-1.12)	1.05 (0.83-1.33)
Age	1.01 (0.99-1.03)	0.98 (0.96-0.99)*	0.99 (0.98-1.01)	0.99 (0.97-1.00)	0.89 (0.82-0.97)**	1.02 (0.89-1.17)
Female	0.95 (0.74-1.24)	1.03 (0.89-1.35)	0.85 (0.66-1.10)	0.75 (0.58-0.98)*	0.68 (0.34-1.36)	0.66 (0.22-1.94)
Black	1.02 (0.70-1.48)	1.05 (0.71-1.56)	1.34 (0.93-1.92)	0.93 (0.63-1.38)	0.75 (0.26-2.150	1.90 (0.49-7.34)
Other Race	1.01 (0.63-1.61)	0.95 (0.58-1.55)	0.93 (0.58-1.49)	0.98 (0.62-1.57)	0.74 (0.18-2.95)	1.22 (0.16-9.50)
Depressive Symptoms	1.03 (0.99-1.06)	1.02 (0.99-1.05)	0.99 (0.97-1.03)	1.01 (0.98-1.04)	0.97 (0.89-1.04)	1.00 (0.88-1.13)
Tobacco use	1.37 (0.95-1.96)	0.96 (0.65-1.44)	1.33 (0.93-1.90)	0.77 (0.51-1.16)	0.88 (0.30-2.59)	2.93 (0.63-13.6)
Physical Activity	0.98 (0.88-1.09)	1.12 (0.99-1.27)	0.98 (0.88-1.09)	1.06 (0.94-1.19)	0.81 (0.62-1.08)	1.24 (0.65-2.36)
Obesity	1.11 (0.86-1.43)	0.79 (0.60-1.04)	1.04 (0.80-1.35)	1.19 (0.91-1.54)	0.80 (0.42-1.50)	0.71 (0.25-2.07)
W1 Meeting Attendance	1.21 (1.13-1.29)***	1.11 (1.04-1.19)**				
W1 Volunteering			1.08 (1.02-1.16)*	0.95 (0.89-1.02)		
W1 Caregiving					0.74 (0.39-1.40)	0.98 (0.45-2.15)
W1 Employment						

Table Continued

	Caregiving (n=1,599)	
	Decrease	Increase
	OR (95% CI)	OR (95% CI)
Human Capital		
Education	0.99 (0.85-1.17)	0.75 (0.62-0.91)**
Functional Limitations	0.97 (0.84-1.11)	0.95 (0.79-1.13)
Social Capital		
Married	1.76 (1.22-2.56)**	1.61 (1.04-2.51)*
Network Size	1.01 (0.90-1.12)	1.21 (1.06-1.37)**
Support	1.08 (0.71-1.63)	0.99 (0.61-1.62)
Cultural Capital		
Religious Service Attendance	1.03 (0.95-1.11)	1.02 (0.93-1.12)
Age	1.00 (0.97-1.04)	1.02 (0.98-1.06)
Female	1.33 (0.94-1.88)	0.90 (0.60-1.37)
Black	1.63 (1.04-2.57)*	1.46 (0.85-2.53)
Other Race	0.68 (0.33-1.37)	0.95 (0.45-2.00)
Depressive Symptoms	1.02 (0.98-1.05)	0.98 (0.94-1.03)
Tobacco use	0.76 (0.44-1.31)	1.14 (0.63-2.06)
Physical Activity	1.05 (0.91-1.21)	1.03 (0.87-1.22)
Obesity	0.86 (0.62-1.20)	1.24 (0.85-1.81)
W1 Volunteering		
W1 Meeting Attendance		
W1 Caregiving		
W1 Employment	0.99 (0.79-1.25)	0.99 (0.76-1.29)

*p<.05, **p<.01, ***p<.001

Appendix E Ordinal Logistic Regression Predicting Frequency of Volunteering Meeting Attendance

	Volunteering W1 (n=2,259)		Volunteering W2 (n=1,069)		Meeting W1 (n=2,260)		Meeting W2 (n=1,152)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Human Capital								
Education	1.48***	1.37-1.61	1.24***	1.10-1.39	1.57***	1.45-1.71	1.44***	1.29-1.62
Functional Limitations	0.88***	0.83-0.94	1.03	0.92-1.15	0.91*	0.85-0.96	1.03	0.93-1.15
Social Capital								
Married	0.93	0.78-1.11	1.10	0.85-1.42	0.89	0.75-1.06	0.76*	0.59-0.97
Network Size	1.14***	1.08-1.20	1.06	0.98-1.15	1.10***	1.05-1.16	1.00	0.93-1.08
Support	1.46***	1.18-1.79	0.97	0.71-1.33	1.19	0.97-1.45	1.34	0.99-1.80
Cultural Capital								
Religious Service Attendance	1.49***	1.43-1.55	1.27***	1.19-1.36	1.34***	1.29-1.40	1.15***	1.08-1.22
Age	1.01*	1.00-1.02	1.01	0.99-1.04	1.00	0.99-1.02	1.02	0.99-1.04
Female	1.08	0.91-1.28	0.92	0.71-1.19	1.27**	1.08-1.50	1.05	0.82-1.34
Black	1.07	0.86-1.35	0.93	0.66-1.32	1.23	0.99-1.53	0.99	0.72-1.37
Other Race	0.71*	0.51-0.97	0.73	0.43-1.25	0.56***	0.41-0.77	0.63*	0.40-0.99
Depressive Symptoms	0.98*	0.96-1.00	0.99	0.96-1.02	0.98	0.97-1.00	1.01	0.98-1.04
Tobacco use	0.85	0.67-1.08	0.70	0.47-1.03	0.76*	0.60-0.95	0.73	0.50-1.06
Physical Activity	1.09*	1.02-1.17	1.11	0.99-1.25	1.15***	1.08-1.23	1.21***	1.08-1.35
Obesity	1.01	0.85-1.19	0.88	0.69-1.11	1.03	0.88-1.21	1.03	0.82-1.29
Selection λ			0.34	0.10-1.22			0.32	0.10-1.04
W1 Volunteering							1.29***	1.21-1.37
W1 Meeting Attendance			1.48***	1.39-1.59				

*p<.05, **p<.01, ***p<.001

Appendix F Logistic Regression on the Maintenance of Caregiving

	Caregiving Maintainers (n=254)	
	OR	95% CI
Human Capital		
Education	0.93	0.67-1.27
Functional Limitations	1.20	0.91-1.58
Social Capital		
Married	1.06	0.52-2.19
Network Size	1.19	0.97-1.47
Support	0.53	0.24-1.16
Cultural Capital		
Religious Service Attendance	0.97	0.84-1.12
Age	0.99	0.92-1.05
Female	1.27	0.64-2.50
Black	2.42*	1.04-5.64
Other Race	0.80	0.18-3.64
Depressive Symptoms	0.99	0.93-1.06
Tobacco use	1.95	0.66-5.75
Physical Activity	1.47*	1.05-2.05
Obesity	1.41	0.75-2.67
Selection λ	0.35	0.01-8.68
Pseudo R^2	0.0609	

*p<.05, **p<.01, ***p<.001

Appendix G Changes in Capital Predicting Frequency of Productive Activities, Wave 2

	Volunteering (n=1,593)		Meeting Att. (n=1,593)		Employment (n=599)		Caregiving (n=1,196)	
	b	SE	b	SE	OR	95% CI	OR	95% CI
Human Capital								
Education	.12**	.04	.26***	.05	1.21*	1.01-1.45	.75**	0.61-0.92
Δ in Functional Limitations	-.01	.03	-.08**	.03	.81*	0.69-0.96	.93	0.80-1.07
Social Capital								
Married	.07	.13	-.09	.14	1.06	0.60-1.88	3.17**	1.46-6.87
Δ in Network Size	.05	.03	-.02	.03	1.05	0.93-1.18	1.16*	1.01-1.33
Δ in Support	.17	.10	.01	.11	.87	0.57-1.32	.83	0.51-1.35
Cultural Capital								
Δ in Religious Service Attendance	.17***	.03	.13***	.03	.98	0.87-1.10	.95	0.83-1.10
Age	-.01	.01	.02*	.01	1.00	0.96-1.04	1.01	0.97-1.05
Female	.07	.09	.06	.09	.77	0.53-1.13	.76	0.49-1.16
Black	.08	.12	-.05	.13	.82	0.49-1.37	1.25	0.68-2.30
Other Race	-.07	.16	-.19	.17	.85	0.45-1.60	.99	0.46-2.14
Depressive Symptoms	-.01	.01	.01	.01	.98	0.93-1.03	.97	0.92-1.02
Tobacco use	.03	.02	.04	.03	.95	0.92-1.02	.96	0.93-1.01
Physical Activity	.05	.04	.08	.04	.94	0.80-1.11	.98	0.81-1.17
Obesity	-.10	.09	.16	.09	.77	0.54-1.09	1.12	0.74-1.71
W1 Volunteering	.48***	.02	.19***	.03				
W1 Meeting Attendance	.21***	.02	.43***	.03				
Selection λ	-.10	.36	-1.07**	.39	.19	0.27-1.30	.74	0.13-4.30
Constant	.90	.49	-.66	.52				
R^2	.4385		.3841		--		--	
Pseudo R^2	--		--		.0384		.0348	

*p<.05, **p<.01, ***p<.001

Appendix H Ordinary Least Squares Regression Predicting W1 CRP in NSHAP (n=1,790)

	Volunteering		Attending Meetings		Caregiving		Employment	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Volunteering	-.03*	.01						
Attending Meetings			-.02	.01				
Caregiving					-.03	.02		
Employment							-.04	.04
Age	-.01	.01	-.01	.00	-.01	.01	-.01	.01
Female	.18***	.05	.17**	.06	.18**	.05	.16**	.05
Black	.24**	.08	.24**	.08	.24**	.08	.22**	.08
Other Race	-.08	.10	-.08	.10	-.07	.10	-.08	.10
Married	-.08	.06	-.08	.06	-.07	.06	-.09	.06
Education	-.08**	.03	-.08**	.03	-.09***	.03	-.09**	.03
Low Net Worth	-.09	.07	-.08	.07	-.07	.08	-.08	.07
Tobacco Use	.20**	.07	.21**	.08	.22**	.07	.21**	.07
Physical Activity	-.06**	.02	-.06**	.02	-.06**	.02	-.06**	.02
Obesity	.53***	.05	.53***	.05	.53***	.05	.53***	.05
Depressive Symptoms	.01	.01	.01	.01	.01	.01	.01	.01
Emphysema	.16*	.08	.16*	.08	.16*	.08	.16	.08
Asthma	-.03	.08	-.03	.09	-.02	.08	-.03	.08
Diabetes	.03	.06	.03	.07	.03	.06	.03	.06
Lipid Medication	-.24***	.05	-.24***	.05	-.24***	.05	-.24***	.05
Constant	.58	.29	.58	.33	.55	.29	.72	.32
Adjusted R^2	.1200		.1178		.1199		.1176	

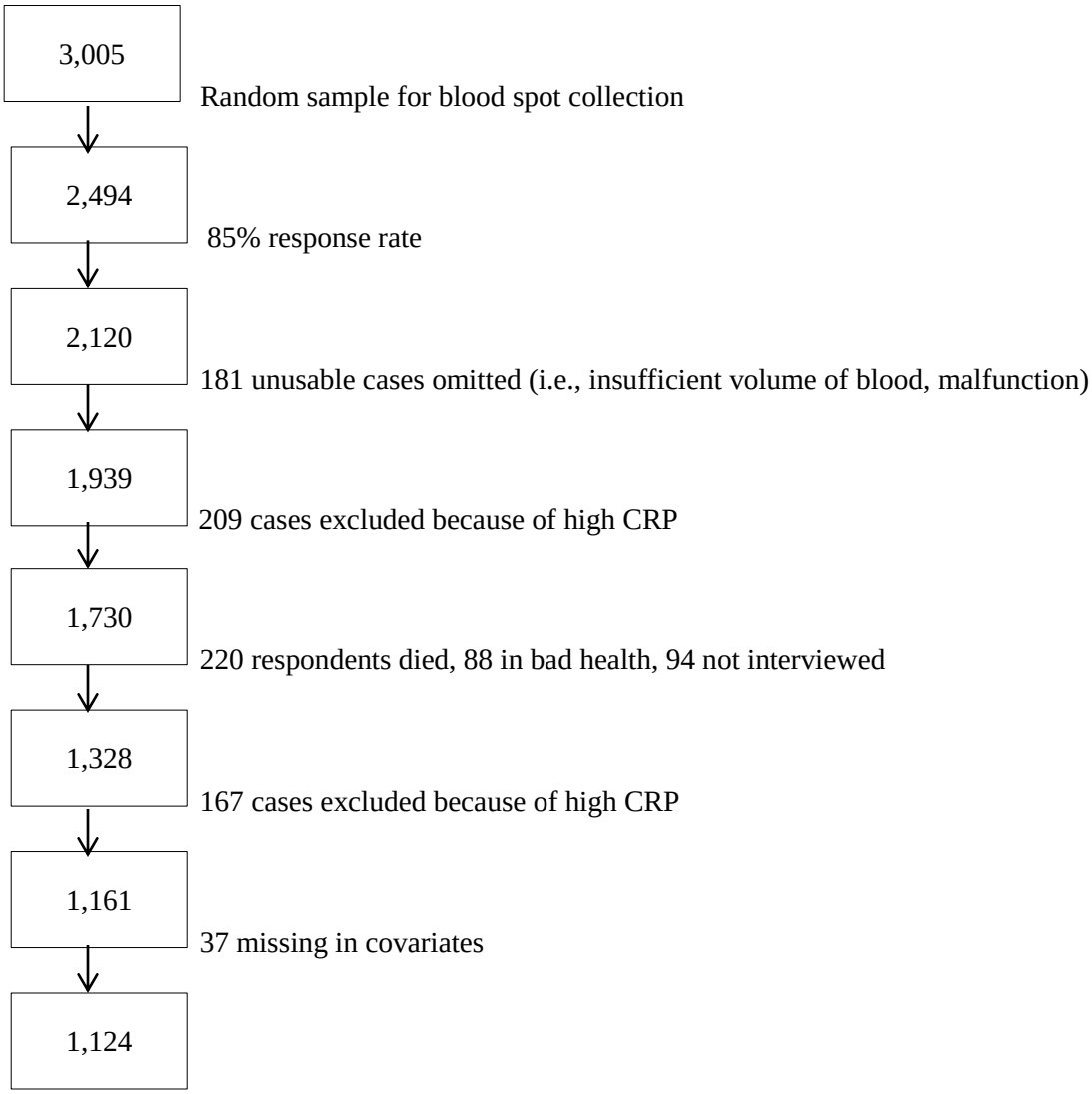
*p<.05, **p<.01, ***p<.001

Appendix I Ordinary Least Squares Regression Predicting Changes in CRP, Stratified by Gender

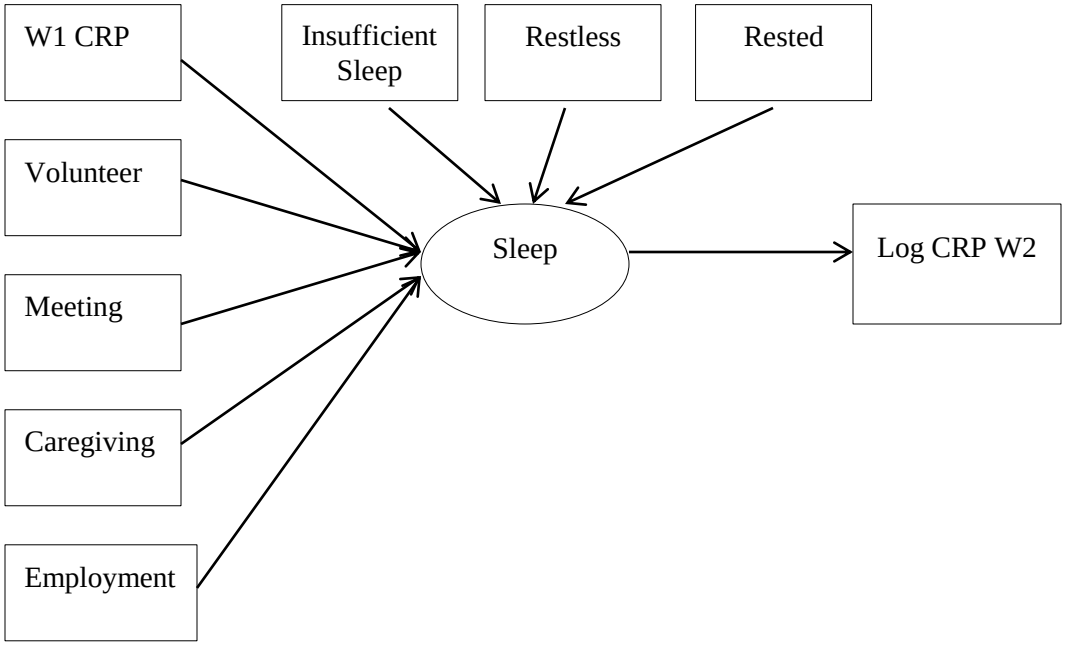
	Attending Meetings				Employment			
	Women (n=573)		Men (n=551)		Women (n=573)		Men (n=551)	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Increase Activity	.15	.12	-.12	.13	.02	.16	.45*	.18
Decrease Activity	-.09	.12	-.08	.12	-.03	.10	.03	.10
Maintain Activity	-.07	.13	-.29*	.13	-.20	.13	.11	.11
Age	-.02**	.01	.01	.01	-.02**	.01	.01	.01
Black	-.05	.10	.15	.14	-.05	.10	.15	.14
Other Race	.15	.15	.01	.14	.16	.15	.03	.14
Married	-.12	.07	-.13	.10	-.16*	.08	-.15	.10
Education	.01	.04	-.01	.04	.02	.04	-.02	.04
Low Net Worth	-.08	.09	-.08	.12	-.07	.09	-.06	.11
Tobacco Use	.06	.11	.05	.11	.05	.11	.05	.11
Physical Activity	.03	.03	.02	.04	.02	.03	-.01	.04
Obesity	.16*	.08	.29***	.08	.16*	.08	.31***	.08
Depressive Symptoms	-.01	.01	.01	.01	-.01	.01	.01	.01
Emphysema	-.08	.11	.32*	.12	-.10	.12	.30*	.12
Asthma	.04	.12	.21	.13	.04	.12	.25	.13
Diabetes	-.07	.09	.01	.09	-.08	.09	.03	.09
Lipid Medication	-.03	.07	-.08	.08	-.03	.07	-.09	.08
Wave 1 CRP	.24***	.02	.21***	.02	.25***	.02	.21***	.02
Selection λ	.64*	.26	-.07	.31	.61*	.26	.09	.32
Constant	1.26	.46	-.10	.51	1.46	.48	-.25	.52
Adjusted R^2	.3030		.2113		.2937		.2122	

Note: The reference group is no activity at W1 and W2. The results are graphically depicted in Figure 1 and 2.
*p<.05, **p<.01, ***p<.001

Appendix J Analytic Sample Flow Chart, NSHAP 1 and 2



Appendix K Hypothesized Structural Equation Model Predicting CRP at W2



Results of Structural Equation Model Predicting Changes in CRP (n=1,124)

	Model 1	
	Coefficient	SE
→ Sleep		
Volunteering	-.01	.00
Attending Meetings	-.01	.00
Caregiving	.02	.01
Employment	-.02	.01
Age	-.01	.01
Female	.04	.01
Black	-.01	.01
Other Race	-.01	.02
Married	.01	.01
Education	.01	.01
Low Net Worth	.03	.02
Smoking	-.01	.01
Physical Activity	-.01	.01
Obesity	.04	.02

Depressive Symptoms	.01	.01
Emphysema	.02	.01
Asthma	.01	.02
Diabetes	.01	.01
Lipid Medication	.02	.02
Selection Lambda	.02	.02
→ W2 CRP		
Sleep	.38	.22
W1 CRP	.25***	.02
Age	-.01	.01
Female	.01	.07
Black	.16	.11
Other Race	.11	.13
Married	-.11	.07
Education	-.02	.03
Low Net Worth	-.01	.09
Smoking	.01	.09
Physical Activity	.04	.03
Obesity	.24***	.06
Depressive Symptoms	-.01	.01
Emphysema	.11	.10
Asthma	.11	.10
Diabetes	-.05	.08
Lipid Medication	-.05	.06
Selection Lambda	.08	.25
Measurement Model		
Insufficient Sleep	1.00	
Rested (Reverse Coded)	3.64***	.36
Restless	4.49***	.45
RMSEA	0.021	
CFI	0.983	
TLI	0.956	

*p<.05, **p<.01, *** p<.001

Note: All paths are controlled for covariates and nonrandom selection effects specified in the main regression models.

VITA

VITA

Seoyoun Kim

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Education

May 2015	Dual-Title Ph.D in Sociology and Gerontology Purdue University, West Lafayette, Indiana *Dissertation Title*: The Social Antecedents and Health Consequences of Productive Activity. *Committee*: Kenneth F. Ferraro (Chair), Elliot M. Friedman, Sarah A. Mustillo, and Patricia Thomas
2011	M.S. in Sociology Purdue University, West Lafayette
2009	B.A. in Sociology, *Summa cum laude* Michigan State University, East Lansing

Area of Interest

Aging and the Life Course; Physical and Mental Health; Quantitative Methods

Fellowships and Grants

2014-2015	Bilsland Dissertation Fellowship, Purdue University Graduate School
2013	Finalist for the Purdue Korean Association Academic Excellence Fellowship, Purdue University
2009-2010	Ross Fellowship, Purdue University

Honors and Awards

2014	Funding awarded to attend the RAND Summer Institute, RAND Corporation
2014	Winner of the Certificate of Excellence Award, Office of Interdisciplinary Graduate Program (OIGP), Purdue University Project title: Health Benefits of Religion among Black and White Older Adults: Does Religiosity Reduce Chronic Inflammation?

2013 Winner of the Certificate of Excellence Award, Office of Interdisciplinary Graduate Program (OIGP), Purdue University
Project title: Do Productive Activities Reduce Inflammation in Later Life? Multiple Roles, Frequency of Activity, and C-Reactive Protein

2010 *Golden Key Honor Society* (Purdue Chapter)

2009 Ruth Hamilton Award for Academic Excellence, Michigan State University

Publications

Kenneth F. Ferraro, and **Seoyoun Kim**. 2014. "Health Benefits of Religion among Black and White Older Adults? Race, Religiosity, and C-Reactive Protein." *Social Science and Medicine* 120: 92-99.

Kim, Seoyoun, and Kenneth F. Ferraro. 2014. "Do Productive Activities Reduce Inflammation in Later Life? Multiple Roles, Frequency of Activities, and C-Reactive Protein. *The Gerontologist* 54(5): 830-839.

* Highlighted on Purdue Exponent, Lafayette Journal and Courier, and other news outlets

* Named Editor's Choice by *The Gerontologist*

Gilligan, Megan, Jill Suitor, **Seoyoun Kim**, and Karl Pillemer. 2013. "Differential Effects of Perceptions of Mothers' and Fathers' Favoritism on Sibling Tension in Adulthood." *Journal of Gerontology: Social Sciences* 68(4): 593-598.

Manuscripts in Progress or Under Review

"Social Support, Psychological Resources, and Health: Potential Pathways?," with Patricia Thomas

"Social Antecedents of Productive Activity: The Role of Human, Social, and Cultural Capital?"

"Relationships with Children-in-law and the Quality of Intergenerational Relationships," with Jori Sechrist, J. Jill Suitor, Kaitlin Johnson, and Karl Pillemer.

Papers Presented at Professional Meetings

2014 "Social Support, Psychological Well-being, and Chronic Inflammation: Potential Pathways?" Presented at the annual meeting of the Gerontological Society of America, Washington D.C.

2013 "Social Antecedents of Inflammation in Later Life: Do Productive Activities Reduce C-Reactive Protein?" Presented at NSHAP early wave 2 conference. Chicago, IL.

2013 "Do Productive Activities Reduce Inflammation in Later Life? Multiple Roles, Frequency of Activities and C-Reactive Protein. Presented at the 20th meeting of International Association of Gerontology and Geriatrics, Seoul, Korea.

2012 "Academic Achievement and Parents' Marital Satisfaction: The Roles of Parental Expectations and Child's Health" Presented at the annual meeting of the American Sociological Association (ASA), Denver, CO.

2011 "Adult Children's Marital Distress and Psychological Well-being: The Moderating Role of Parent-Child Relationship Quality." Presented at the annual meeting of the Gerontological Society of America (GSA), Boston, MA.

2011 "Effects of In-law Relationships Quality on Mother-Adult Child Relationship." Presented at the International Conference on Successful Aging, Seoul, Korea.

2010 "Relationships with Children-in-law and the Quality of Intergenerational Relationships." Presented at the Annual meeting of the Gerontological Society of America (GSA), New Orleans, LA.

Research and Teaching Experience

Research Assistant

2009-2011 Research Assistant. "Within-Family Differences Study" J. Jill Suitor Principal Investigator. Funded by the National Institute on Aging (2RO1AG18869-04)

Graduate Instructor

2014 SOC382: Introduction to Social Statistics (Undergraduate Level)
Overall Instructor Rating: 4.2 / 5

2013 SOC382: Introduction to Social Statistics (Undergraduate Level)
Overall Instructor Rating: 4.7 / 5

2012 SOC220: Social Problems (Undergraduate Level)
Overall Instructor Rating: 4.8 / 5

Teaching Assistant

2013 SOC382: Introduction to Social Statistics (Undergraduate Level)
2012 SOC100: Introduction to Sociology (Undergraduate Level)
2011 SOC572: Comparative Healthcare (Graduate Level)
2011 SOC573: Human Side of Medicine (Graduate Level)

Professional Service

Manuscript Reviewer for *Research on Aging* and *Journal of Marriage and Family*
Symposium and Poster Abstract Reviewer for the Gerontological Society of America

2011-2013 Student representative, Office of Interdisciplinary Graduate Programs

2008-2009 Undergraduate Assistant, Department of American Studies, Michigan State University

Additional Skills and Training

Quantitative Skills Development

2014	User Workshop on the HRS Family of Data Sets, RAND Corporation
2014	Methods for Establishing Causality: Quantile Regression, Purdue University
2013	A Formal Test of Moderated Mediation Workshop, Purdue University
2010	Introduction to Growth Curve Modeling in Mplus Workshop, Purdue University
2010	Seeing the Forest through the Trees: Dealing with Missing Data in Quantitative Analyses, Purdue University

Professional Development

2014	Mini-Medical School for Social Scientists and the Demography, Economics, Psychology, and Epidemiology of Aging Workshop, RAND Corporation
2012	Grant and Proposal Writing Workshop, Purdue University
2010	Research Integrity Workshop, Purdue University
2010	Teaching College Student Workshop, Purdue University

Software and Technical Skills

Statistical software: Stata, Mplus, and SPSS
Statistical methods: linear regression, categorical data analysis, growth curve modeling, multiple imputation, structural equation modeling, Heckman model for sample selection effects, and clustered observations

Professional Memberships

American Sociological Association
Section on Aging and the Life Course (SALC)

Gerontological Society of America